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PB-297 028

Areawide Waste Treatment and Water Quality Management Planning. Appendix B-1. Non-Point Sources of Water Pollution in the 208 Area

Greater Egypt Regional Planning and Development Commission, Carbondale, IL

Prepared for

Environmental Protection Agency, Chicago, IL. Region V

Nov 78

PB 297028

Areawide Waste Treatment and Water Quality Management Planning

Non-point Sources of Water Pollution in the 208 Area

Appendix B-1

Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Perry, Pope, Saline, and Williamson Counties, Illinois

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Areawide Waste Treatment and Water Quality Management Planning

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Non-point Sources of Water Pollution in the 208 Area

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The preparation of this report was financed entirely with federal funds from the U.S. Environmental Protection Agency under grant number P005225-01 through a contract with the Greater Egypt Regional Planning and Development Commission. The contents do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. Publication No. GERPDC-78-486.

BIBLIOGRAPHIC DATA SHEET	1. Report No. GERPDC-78-486	2.	3. Recipient's Accession No. PB297028
4. Title and Subtitle Areawide Waste Treatment and Water Quality Management Planning Nonpoint Sources of Water Pollution in the 208 Area, Appendix B-1			5. Report Date November 1978 6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Greater Egypt Regional Planning and Development Commission P.O. Box 3160 Carbondale, IL 62901			10. Project/Task/Work Unit No. 11. Contract/Grant No. P005225-01
12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency Region V 230 South Dearborn Chicago, IL 60604			13. Type of Report & Period Covered Final 14.

15. Supplementary Notes

16. Abstracts

The Nonpoint Sources of Water Pollution in the 208 Area is Appendix B-1 of the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois. The Report was prepared under Section 208 of the Water Pollution Control Act, as amended. The Report discusses in detail the nonpoint pollution sources including flourspar and coal mining, petroleum extraction, silviculture, construction, hydrographic modification, rural sewage and agriculture. The report includes recommendations for control of the nonpoint pollution sources, and discusses implementation measure.

17. Key Words and Document Analysis. 17a. Descriptors

Water pollution, agriculture, water quality, mining, erosion.

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
National Technical Information Service U.S. Department of Commerce Springfield, VA 22151	UNCLASSIFIED	108
	20. Security Class (This Page) UNCLASSIFIED	22. Price A06-A01

FORM NTIS-35 (REV. 3-72)
THIS FORM MAY BE REPRODUCED
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November 1978

Michael P. Mauzy
Acting Director
Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, Illinois 62706

Dear Mr. Mauzy:

The Commission is pleased to transmit Appendix B-1, Non-Point Sources of Water Pollution in the 208 Area of the 208 Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois. The plan and this document cover the ten Illinois Counties of Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Perry, Pope, Saline, and Williamson.

This technical report is an integral part of the Southern Illinois Water Quality Management Plan that is designated to meet the contract requirements of Federal Grant Number P005225-01 under the U. S. Water Pollution Control Act Amendments of 1972, as administered by the United States Environmental Protection Agency.

We trust this submittal of this report, as well as the others comprising the plan, will provide the basis for certification of the plan and continued designation of this area.

Sincerely,

A. S. Kirkikis

A. S. Kirkikis
Executive Director

ASK:db

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ACKNOWLEDGMENTS

The Greater Egypt Regional Planning and Development Commission and the Southeastern Illinois Regional Planning and Development Commission wishes to acknowledge the

United States Environmental Protection Agency

for financial assistance in the preparation of this report.

The Regional Commissions express their appreciation to the Illinois Environmental Protection Agency for their assistance and cooperation during the initial planning program.

In addition, the Regional Commissions would like to thank the members of the Technical and Policy Advisory Committees to the program; the Federal and State Agencies; and the many public officials and citizens too numerous to mention who have offered information and suggestions during the initial phase of the planning program.

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PREFACE

Nonpoint sources of water pollution diffuses in nature is not easily isolated or treated. The term "nonpoint sources" can be defined as any pollution source not traceable to a specific point of entry to surface waters. This class of pollution usually enters surface waters in precipitation runoff from land exposed over a relatively large area. The actual pollution source may be an accidental spill of some pollutant, materials leached from mine overburden or areas of exposed soil, materials applied for various purposes to areas of cultivated soil (including forests), from disturbed stream beds and banks, or other sources.

This report addresses eight nonpoint sources of water quality degradation identified in the 10-county Southern Illinois 208 Area. Each has been discussed in a earlier series of interim reports which identified water quality management issues. This work is designed to present data and comments on the nature and impact of these nonpoint sources and to make recommendations concerning management controls and management agencies which will be incorporated in the Areawide Waste Treatment Management Plan for Southern Illinois.

Three of the nonpoint sources discussed in this report have been identified as major or unique pollution problems in the 208 area. These sources are addressed in greater detail in separate reports that are appended to the Areawide Waste Treatment Management Plan for Southern Illinois. These nonpoint sources and the titles of the reports in which they are more fully discussed are as follows:

Coal mining: Technical Report for the Southern Illinois 208 Mine Waste Control Program--Appendix C-3.

Agriculture: Pollution Sources: Agriculture--Appendix B-2.

Rural sewage: Rural Sewage in the 208 Area--Appendix B-3.

The impact of acid drainage from exposed coal mine refuse is the most serious pollution problem in the 208 area. The pollution originates with gob, slurry, and acidic overburden at old tipple sites, and unreclaimed surface mined areas. Sulfuric acid, dissolved metalic salts, and

precipitated coatings of "yellow boy" all seriously impact streams and ponds in affected parts of the 208 area. As a result, some surface waters have been rendered unable to support aquatic life, many are sufficiently degraded so as to be unsafe for stock to drink, and others are particularly unsightly because of yellow encrustations, orange water and dead trees.

Extensive crop farming in the 208 area, and related activities, contribute to an adverse impact on surface and sub-surface waters. Some 2,600 square miles of the 208 area is agricultural land with three quarters of that used for crops. These agricultural lands contribute sediment as well as nitrates, phosphates, herbicides, pesticides, animal wastes and other pollutants to the surface water runoff of the 208 area.

Extensive channelization and the relocation of stream beds in the 208 area contribute to the water quality problems. Problems created by these activities have high priority for consideration. U. S. Army Corps of Engineers projects have included straightening and deepening of more than 50 miles of Saline basin streams. Soil holding brush and trees have been removed causing sedimentation problems as well as eliminating many acres of wildlife cover and forage. This activity causes the mine waste polluted waters of the Saline system to move more rapidly toward the Ohio River, allowing less time for pollutant to be modified by natural ants to be modified by processes. Erosion and siltation problems are also increased.

Seepage from rural sewage systems to surface and subsurface waters is an extensive and difficult problem in the 208 area. Generally speaking, soils in the area are not sufficiently pervious to accept flow from the lateral fields of septic systems using present day technology. The problem is amplified by the failure of private owners to properly maintain septic systems, this failure is usually based upon a lack of knowledge of local soils and their characteristics. Laws requiring properly operating sewage systems (where applicable) are not always sufficiently enforced.

Nonpoint pollution from the area's petroleum extraction, fluorspar mining, silviculture and construction activities are not as great a problem as it is from the previously mentioned sources, but potential problems do exist. In all cases the technology exists for the development of control measures which can prevent water quality degradation while reversing the results of past pollution. These control possibilities will be discussed in the following sections.

Chapter 1

FLUORSPAR MINING NONPOINT SOURCE POLLUTION

Three types of fluorspar deposits are mined in the 208 area of Southern Illinois. Each requires a different mining method. Veins following fault lines and bedded replacement type deposits are mined in underground mines up to 900 feet deep. Secondary or residual deposits left by weathering of veins and beds are removed from open pits. Underground mining involves shrinkage stopping, tunneling, and room and pillar methods. Surface mining is done by open pit methods using bulldozers, power shovels, and draglines. A washing process is neccessary to separate fluorspar from other materials.

Fluorspar ore is treated at mills using froth flotation or heavy media separation techniques. In the froth flotation approach, the ore is crushed and ground to a powder. The powdered ore is air frothed with chemical reagents. The froth is vacuum filtered to obtain a concentrate. By varying the reagents, fluorite, sphalerite (zinc ore), or galina (lead ore) can be produced from the process. Slurry from the froth and filter process goes to a tailings pond. Heavy media separation techniques involve use of a ferro-silicon suspension and separation of fluorspar by specific gravity. Waste material is floated away with the overflow and the ferro-silicon is recovered magnetically.

Exploration for fluorspar involves taking of drill cores. Drilling set-up requires an area about 30 feet in diameter. Roads to the drill site are usually graded through forest in hilly terrain. Heavy vehicles are needed to move the drilling equipment. Several thousand gallons of water daily are pumped into the drill hole and return to the surface with sediments. This slurry is a potential source of increased sedimentation for nearby streams. Drill holes are usually plugged after the core is removed.

Sediments eroded from roads and trampled area around drill sites and from piles of diggings at mine shaft sites are also a potential non-point source of stream pollution.

Fluorspar mining is confined to two of the ten counties of the 208 area. Hardin County where six mines are currently active, and Pope County which has one active mine. Figures 1 and 2 show the location of these seven mines. They are found in the Shawnee Hills section of the Interior Low Plateau physiographic province. Relief here is on the order of 200 feet. Most fluorspar deposits in this area are found in rocks of Mississippian age that have been extensively faulted.

Fluorspar has been mined in the 208 area since 1842. Early mines and prospects were in Gallatin, Hardin, Pope, and Saline counties. About 180 old mine sites and 4 or 5 large preparation facilities have been used and abandoned in these four counties in past years. The ore taken from these and current mines has typically averaged 2.2% zinc ore and 0.5% lead ore making recovery of lead and zinc economically feasible along with the recovery of fluorite[1]. Barite is also recovered.

Mining in 1975 from the eight mines then operating, produced 444,201[2] tons of fluorite, zinc, and barite. Lead ore was also mined but not sold. 1974 production included 4,104 tons of zinc and 493 tons of lead recovered from 166,223 tons of fluorspar ore[3].

At the site of each mine about six acres of land are disturbed, including the area around the shaft and the usual access road. Abandoned mine sites typically become revegetated except for the rockyard (usually less than one acre) around the shaft. This means that nearly 1,000 acres of land have been affected by fluorspar mines - about one tenth of them permanently.

Less than 18 acres are affected by the drilling of 200 core holes in one area. No permanent effect accrues from this activity.

Fluorspar mining, exploration, and milling activities do not appear to have extensive nonpoint source impact on water quality. Effects do not extend beyond nearby streams or surface waters in the immediate area of mine-related activities.

Figure 1 ACTIVE FLUORSPAR MINES IN POPE COUNTY

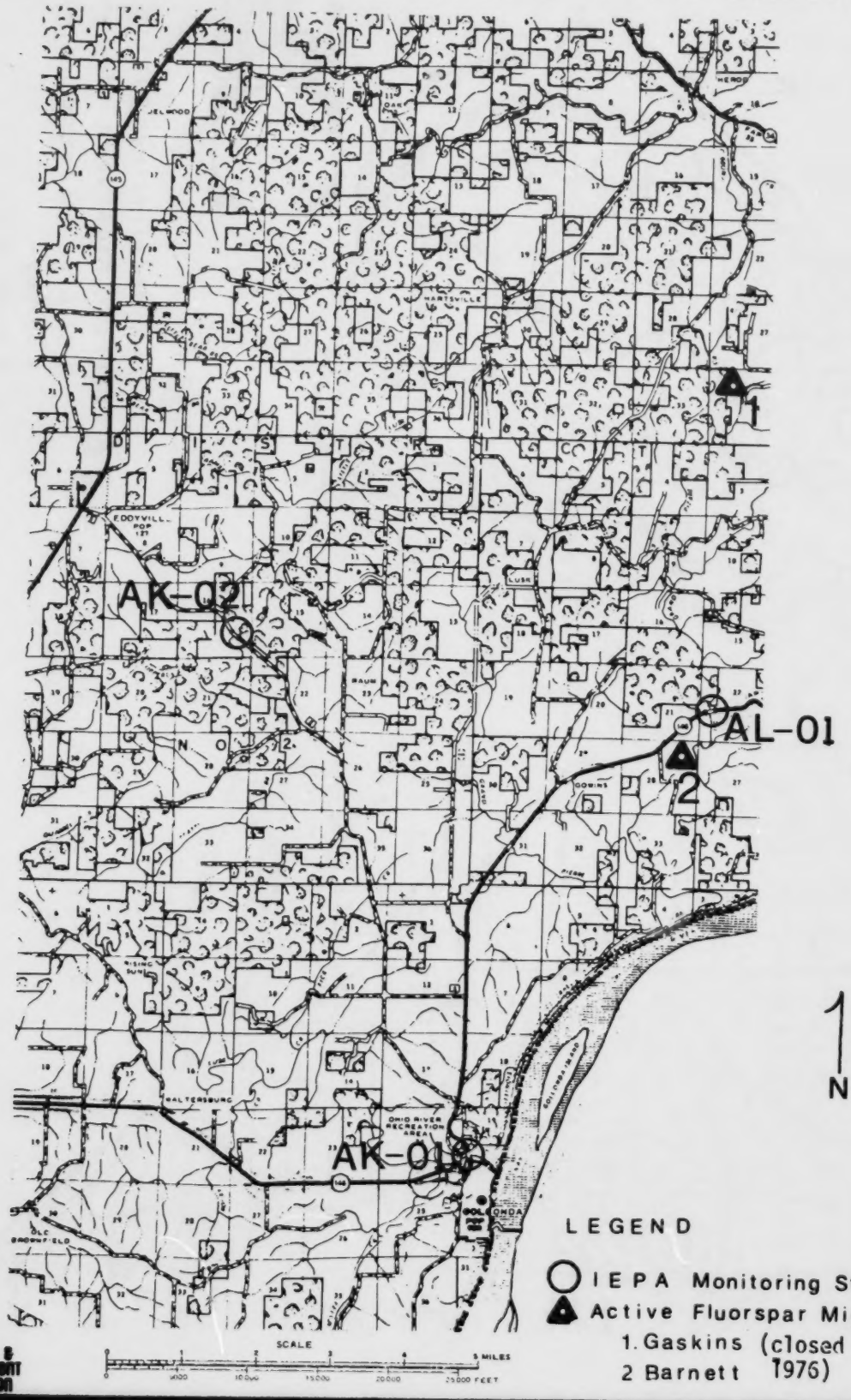

FIGURE 2. ACTIVE FLUORSPAR MINES IN HARDIN COUNTY

Fluorspar is composed of the mineral fluorite (CaF_2, calcium fluoride) and often has sphalerite (Zn S, zinc sulfide); galera (Pb S, lead sulfide); barite ($BaSO_4$, barium sulfate); and calcium carbonate ($CaCO_3$) associated with it. Chalcopyrite (Cu Fe S_2, copper iron sulfide), pyrite and marcosite (Fe S_2, iron sulfide) and smithsonite (Zn, CO_3, zinc carbonate) may also be present.

The presence of sulfides in mineral deposits or wastes of processing raises the possibility of acid runoff from mining and preparation areas. This does not occur in association with Southern Illinois fluorspar mines because of the low percentages of these minerals in the ore, the low solubility of the principal sulfide (galena), and the lack of large amounts of refuse through which water can percolate. In addition, tailing ponds near preparation facilities are self-contained having no outflow and are constructed under supervision of the Mine Enforcement and Safety Administration.

The mineral content of materials mined for fluorspar is also a possible source of heavy metals. The potential is present for increased stream loadings of lead, zinc, iron, and copper. I.E.P.A. water quality monitoring results at sites downstream from active and abandoned mine and mill locations revealed no indication of zinc or fluoride levels above state established standards. Levels of lead, however, did exceed standards on six occasions in 1972 through 1974 (Table 1). Four of these violation levels were within a three month period in 1974 suggesting that some local incident or analytic error may have occurred. The lack of continuity of high lead levels suggests that they bear no direct relationship to fluorspar mining as a nonpoint source. Lead analyses of 18 I.E.P.A. stations in the entire Saline Basin in 1974 and 1975 revealed 25 violations of the lead standard. All violations these occurred in spring and summer of 1974. Most of them did not occur in fluorspar mining areas. This further suggests that Southern Illinois fluorspar mining activities cannot be considered a dangerous source of lead in flowing waters.

Waste rock piles at mine sites, drilling sludge at drill core sites, and erosion from roads in steep terrain and work areas are sources of increased suspended solids in streams. However, waste rock is usually in large chunks, and roads and work areas represent small acreages. There is not much chance of anything beyond localized sedimentation problems in small tributary streams. Drilling uses thousands of gallons of water and puts out corresponding amounts of high sediment slurry.

Table 1
LEAD STANDARD VIOLATIONS IN THE FLUORSPAR REGION OF THE 208 AREA 1972-1974

I.E.P.A. Station	Stream Name	County	Violation Date	mg/l Lead (Standard= 0.1 mg/l)
AK-01	Lusk Creek	Pope	12-6-73	0.12
			3-27-74	0.33
AK-02	Luck Creek	Pope	3-28-74	0.18
AL-01	Big Grand Pierre Cr.	Pope	5-22-74	1.00
AO-01	Big Creek	Hardin	3-28-74	1.16
AT-02	Saline River	Hardin	4-18-72	0.15

This has the potential to increase the sediment load of streams locally. However, drilling is a short term activity and the possible increase of suspended solids transitory.

Fluorspar mining does not appear to be a major factor in nonpoint water pollution. However, certain practices are necessary to keep the potential of these activities for water quality degradation at a minimum. Among these are a continuation of regulatory programs which address mining methods, site design, road construction, stockpiling practices, water handling procedures, mine waste disposal, transportation and storage of reagents, and quality of point source discharges. In addition, sludge from drilling must be impounded in pits and revegetation required in order to minimize impact of drilling operations. Tailings ponds at mine sites should be dewatered and revegetated or reprocessed for unrecovered fluorspar value. These practices plus the usual sealing of old shafts and drill core holes would minimize the impact of fluorspar mining on 208 area streams.

The fluorspar mining districts in the 208 area of Southern Illinois occupy a region known for the high quality of its surface waters. Low concentration of human population and large acreages of relatively undisturbed forested land are the major factors making this high quality possible. If mining activities should increase to any great extent, the potentials for water quality degradation from this source would be reflected in actual surface water pollution problems unless the expansion of activity were accompanied by expanded attention to monitoring, control measures, and site restoration efforts.

Control Implementation

The Regional Water Quality Council or the appropriate designated member agencies should review and comment on applications for mining permits prepared for the Illinois Department of Mines and Minerals and NPDES permits with special attention to site design, road construction, stockpiling practices, water handling procedures, mine waste disposal, and transportation and storage of reagents. Prospecting permits should also be reviewed with special attention to the construction of access roads and their proper maintenance in accordance with practices recommended by the U.S. Forest Service for roads in forested areas, so as to minimize erosion problems.

There should be continued and strategically located monitoring by I.E.P.A. or other appropriate entity of stream water quality downstream of fluorspar mining and processing areas with emphasis on fluoride, lead and zinc concentrations to monitor the effect of the varying levels of production on water quality in streams.

Control Costs

Review of mining and prospecting permits would be a part of the regular activities of the Regional Water Quality Council as would the annual review of water quality improvement progress. Expenses generated by these activities would be part of the regular operating costs of the council.

The strategic monitoring program if carried out by IEPA would have state funding. Eight additional strategically located sites are envisioned where samples would be taken approximately six times per year beginning in 1979. Laboratory expenses and handling of samples for this program reaches a cost estimate of $1,680 per year. Personnel time, travel costs and equipment costs at five to eight percent of one employee would add approximately $1,000 to that figure. A total estimated cost of $2,680 represents additional lab, personnel, travel and equipment costs for this monitoring program each year assuming no increase or decrease in the number of mining locations in the 208 area.

Chapter 2

PETROLEUM EXTRACTION

Crude oil is primarily a mixture of oil and salt water (brine). After wells have been drilled the oil-brine mixture is pumped from oil bearing formations and separated at the surface. Both brime and oil are transported from the well site by truck or by pumping through a pipe. The oil is pumped or trucked to a central transmission point from which it is transported to a refinery. Brine is pumped or trucked from holding tanks to disposal wells where it is usually injected back into the oil-producing formation. Surface waters can be affected by many parts of the total operation including the drilling process, road and drill site construction and use, tranport of oil, transport and disposal of brine, and above ground storage.

In the drilling process, water is piped to the rotating drill bit. Mud formed from its combination with rock particles is brought to the surface and stored in a pit or open tank at the drill site. When drilling is completed, metal pipe is used to case the drill hole. This prevents migration of petroleum and brine into other strata. Wells are also drilled for the sole purpose of brine disposal.

During pumping operations, holding tanks store oil and brine awaiting transport by pipeline or truck. Brine may also be stored in open pits where it is concentrated by evaporation. These pits are lined to prevent seepage. A sufficient evaporation rate makes transport of the brine unnecessary during pumping operations. Abandoned wells are plugged. Marginal producing wells are sometimes converted to use as brine disposal wells.

Nine counties in the ten county 208 project area have some oil production, although two of these showed no production figures recorded with the Illinois State Geological Survey from 1970 through 1974 (Table 2). These counties have produced 11 to 12 percent of total Illinois petroleum production in this 5-year period. In the period 1970 through 1974, 453 oil permits were issued in these nine counties and 86 wells completed (Table 3). Figure 3 shows the location of fields in the ten county 208 project area.

Table 2
OIL PRODUCTION IN THE 208 PROJECT AREA
(barrels)

County	1974	1973	1972	1971	1970
Franklin	513,080	580,215	666,796	772,987	956,200
Gallatin	521,232	562,833	672,787	742,291	833,014
Hamilton	811,826	938,768	1,160,756	1,398,855	1,638,577
Hardin	---	---	---	---	---
Jackson	na*	na	na	na	na
Jefferson	759,925	875,576	966,787	1,095,567	1,132,579
Perry	15,536	15,195	20,259	17,248	18,792
Pope	---	---	---	---	---
Saline	207,845	263,842	369,477	544,922	555,738
Williamson	199,711	200,746	164,140	161,955	158,091
Percent Illinois Production from 208 Project Area	10.99%	11.21%	11.53%	12.11%	12.10%

*Jackson County has had at least one producing well since 1942 but complete information is not available. Total 1976 production was 3,509 barrels.
Source: Illinois State Geological Survey, Illinois Petroleum Series #97, 98, 100, 103, 107, and Jackson County Assessors Office.

Table 3
OIL AND SALT DISPOSAL WELL ACTIVITY
1970-1975, By County

COUNTY	NUMBER PERMITS	WELLS COMPLETED	SALT DISPOSAL WELLS COMPLETED
Franklin	69	17	9
Gallatin	75	13	5
Hamilton	65	21	9
Hardin	0	0	0
Jackson	16	4	0
Jefferson	61	16	13
Perry	38	4	3
Pope	5	0	0
Saline	100	16	5
Williamson	159	12	7
REGION TOTAL	588	103	51

Source: Illinois Department of Mines and Minerals, Annual Reports, 1970-1975.

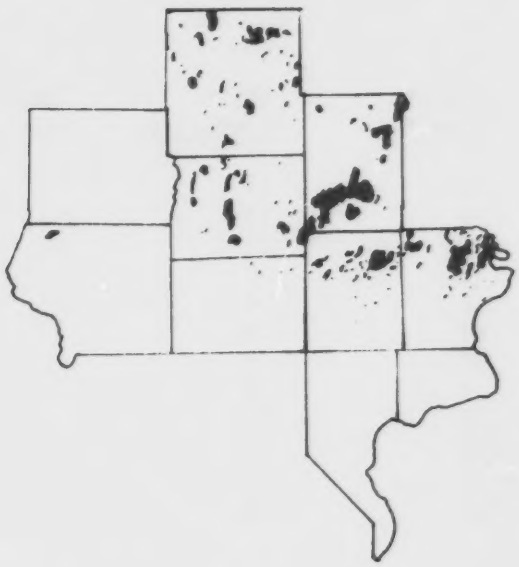

FIGURE 3

Oil Fields In 208 Study Area

Source: Illinois State Geological Survey, Illinois Petroleum #84, p.4.

●- Oil Fields

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A comparison of total production figures for 1970-74 indicates that oil production in the 208 area is declining at a rate of three to four million barrels per year[4]. If this trend continues and precautionary measures are not relaxed, there should be a decreasing impact on surface water quality from oil extraction activities in the area.

Petroleum and gas exploration and extraction can impact water quality in three general ways. These are increased contribution of sediment to runoff due to road construction, on site activities and deposit of drill mud, spills of oil from storage and transport containers and spills of brine. All of these are difficult to quantify, but information from soil conservation service sources indicates that brine contamination is the most serious of these problems.

In Hamilton County, severe salt damage leading to lack of vegetation has occurred in well over 200 locations totaling about 400 acres of affected area (Figure 4). Jefferson and Franklin County soils officials also report severe salt spill damage. Lack of revegetation of brine-affected areas leads to severe local erosion at some of the affected sites. This, plus erosion from service roads and trampled areas around drill sites, contributes sediments and salt to surface waters. It is not possible to quantify this in terms of particulate matter in streams because of the large amount of row crop activity in the same areas which also contribute to stream and pond sedimentation. However, chlorideions have been monitored at IEPA monitoring sites. It is thought that both the salt and the soil erosion problems relate more to old than to operating well sites. Many severe salt-affected areas are thought to be the result of deliberate dumping of brine[5].

Oils spills and leaks sometimes occurr due to pipeline breaks or transport accidents. The most common oil spills occur as leaks from pipelines and are related to cold weather conditions. It is not possible to quantify the impact of these events on water quality since the oil content of streams is not monitored. However, incidents of oil sludge in streams have been reported.

It has been estimated that over six million barrels of brine must be dealt with in one year of oil production,[6] so the potential exists for brine pollution of surface waters if good disposal practices are not followed.

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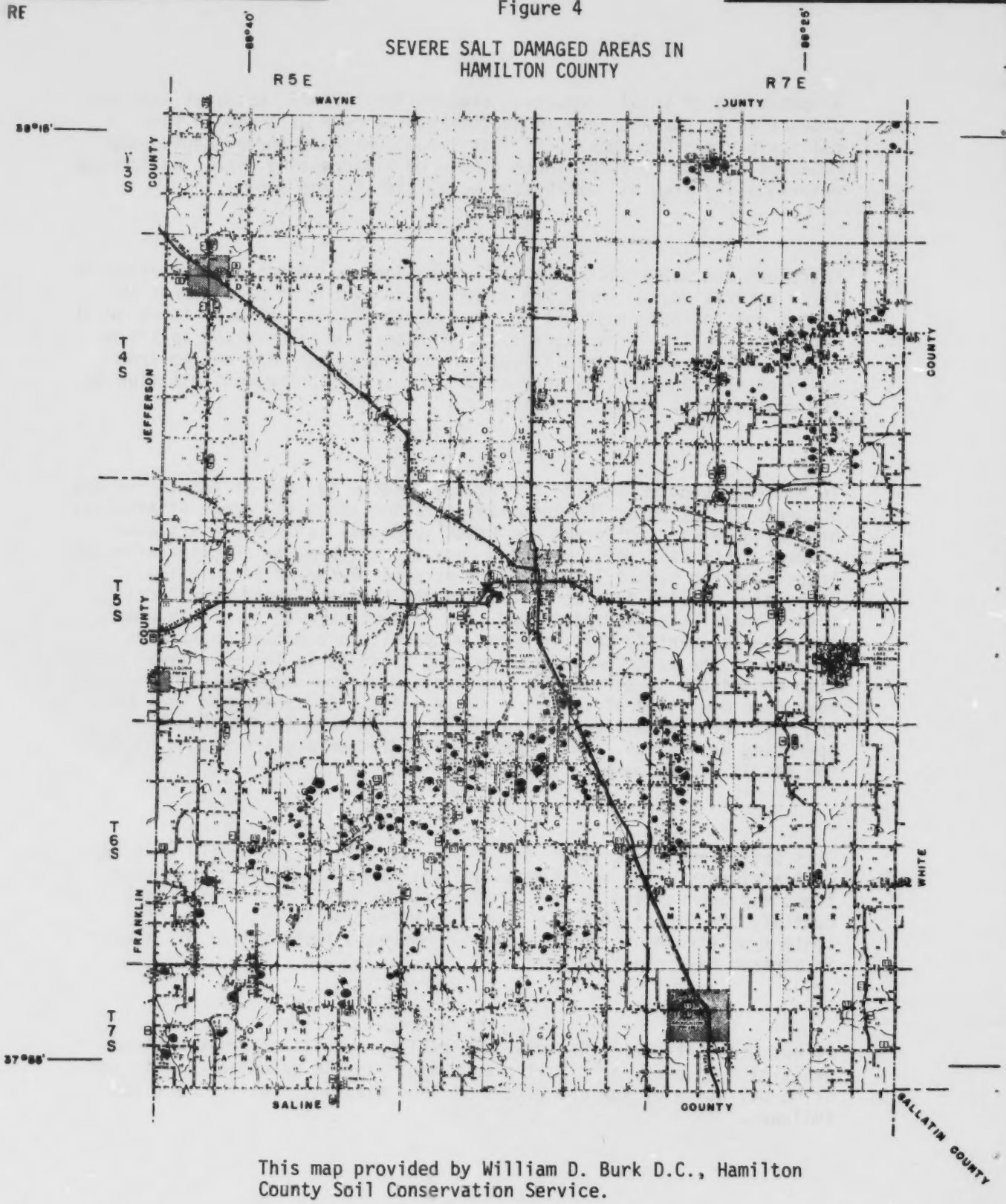
Figure 4

SEVERE SALT DAMAGED AREAS IN HAMILTON COUNTY



This map provided by William D. Burk D.C., Hamilton County Soil Conservation Service.

The stream standard for chloride has been set at 500 mg/l in Illinois. In the years 1968 through 1972, this standard was surpassed at eight monitoring stations in the 208 area (Table 5). These stations are located in Gallatin, Saline, Jackson, and Franklin County. Six of them are located downstream from oil fields and salt water disposal wells. Two of these are also near salt springs. The remaining two, both on the South Fork of the Saline River, are downstream from coal strip mining activities, but do not have known salt springs or oil extraction activities upstream from them. Two stations with excessive chloride incidents reported have been influenced by both oil extraction activities and salt springs. Three stations that did not exceed the 500 mg/l standard in the years 1968-72 had a consistant yearly average over 100 mg/l. All of these were in drainage basins with oil extraction activities. Most of the stations that did exceed 500 mg/l in specific instances did not average 100 mg/l or more for any 12 month period but some did average more than 100 mg/l over the 3 year period.

Of the eight stations which recorded chloride in excess of 500 mg/l during the 1968-1972 period, six had no violations of this standard reported after 1969. By comparing the 1968 - 1972 data (Table 4) to 1976 data (Table 5) it can be seen that there has been a large decrease in chloride ion presence in the streams that showed 1968 - 72 violation levels. Table 7 lists those streams that recorded a chloride average about 100 [illegible] Note that only one of these had a violation level maximum. [illegible] facts emerge from this comparison of data. They are:

1. The number of chloride level violations in streams has decreased.

2. High chloride ion loads have shifted from streams previously affected to others.

3. High chloride levels continue to be associated with streams that have petroleum production in their watersheds.

It appears that these high chloride reports can be associated with oil extraction activities and brine disposal but that in some cases there may be also sources of salt pollution of streams that are not related to extraction of oil. Petroleum extraction appears to be a diminishing water quality threat if oil production continues downward and if salt water waste disposal is properly handled.

Methods for prevention and control of possible pollution due to oil - related activities are now mostly covered in various laws. Among these laws are the following provisions:

Table 4
ILLINOIS EPA MONITORING STATION LOCATIONS WHERE
CHLORIDE STANDARD (500 mg/l) WAS EXCEEDED 1968-72

Station Number	Stream	Location of Station	Average Chloride	Maximum Chloride	Number of Violations
AT-04	Saline River	Rt. 1 bridge 3 mi. S. of Rt. 13	64.8	1200	3
ATF-03	North Fork, Saline R.	N.E. of Equality at Rt. 13 bridge	136.3	790	2
ATG-02	Middle Fork, Saline R.	E. of Harrisburg at Rt. 13 bridge	77.5	1350	3
ATH-01	South Fork, Saline R.	Rt. 34 bridge at Mitchellsville	28.8	1300	3
ATH-05	South Fork, Saline R.	N.E. of Stonefort at U.S. 45 bridge	76.8	2300	4
N-02	Big Muddy R.	At Murphysboro municipal water intake	44.0	755	1
NC-02	Beaucoup Creek	Rt. 149 bridge 1.5 mi. E. of Rt. 127	40.4	840	1
NG-02	Pond Creek	S. edge W Frankfort at Rt. 37 bridge	269.4	1850	2

Source: Illinois Environmental Protection Agency.

Table 5
1976 CHLORIDE FIGURES FOR IEPA STATIONS
LISTED IN TABLE 4

Station	Chloride in mg/l Average	Maximum	Number of Violations
AT-04	42	100	0
ATF-03	83.2	300	0
ATG-02	N.A.	N.A.	N.A.
ATH-01	6.7	10	0
ATH-05	6.3	8	0
N-02	22.3	35	0
NC-02	27.7	50	0
NG-02	49.1	100	0

Source: Illinois Environmental Protection Agency.

Table 6
1976 CHLORIDE LEVELS FOR IEPA STATIONS
SHOWING HIGH CHLORIDE AVERAGE
(all figures are mg/l)

Station Number	Stream	Location of Monitoring Site	Average Chloride	Maximum Chloride	Number of Violations
ATF-04	North Fork, Saline R.	N.E. of Texas City Rt. 45 bridge	161.4	500	0
ATFE-01	Proctor Creek	4 mi. N. of Eldorado, Rural Rd. bridge	106.5	400	0
ATFF-01	Contrary Creek	North of Broughton at Rt. 142	258.1	480	0
ATG-04	Middle Fork, Saline R.	3 mi. N. of Harrisburg, Rt. 34 bridge	122.7	450	0
NK-01	Rayse Creek	4 mi. South of Woodlawn	166.1	650	1

Source: Illinois Environmental Protection Agency.

1. Requirement of permits from the state mining board of the Department of Mines and Minerals before any drilling can be done.

2. The operator is required to plug abandoned drill holes and restore the site to its former condition.

3. There must be no destruction or damage of surface, soil, animal, fish, or aquatic life or property from oil or gas extraction operations.

4. Discharge of oil or other pollutants into the waters of Illinois is prohibited.

5. Refuse pits are to be used in such a way that there will be no spillage of contents.

6. Dikes are required around storage tanks sufficient to hold 1½ times the tank volume if located in a "geographically sensitive" area.

7. The mining board of the state Department of Mines and Minerals is commissioned to inspect leasehold premises and drill sites for violations and to inspect refuse holding pits.

8. The mining board also has power to bring suit against operators who violate laws governing petroleum and gas extraction laws.

9. Operators are given the responsibility to report accidental spills to the State Environmental Services Disaster Agency.

10. The Illinois Department of Mines and Minerals has power to act on complaints regarding oil spills. If they fail to respond the Illinois E.P.A. can act on the complaint.

The strict enforcement of all existing legislation can insure that there will be very little future water quality degradation due to the extraction of oil and gas in the 208 area.

Salt brine damage to many areas in Hamilton, Saline, Franklin, and Jefferson Counties will continue to create localized, critical erosion problems resulting in increased sediment and salt loadings of streams. Because vegetation will not take root in these areas of brine infused soils special erosion control measures may be necessary. Soil and Water

Conservation Districts should be responsible for preparation of an inventory of salt-damaged areas. The impact of sediment and salt eroded areas upon water quality in streams should be assessed along with production loss information so that priorities can be set for the implementation of management activities.

The Regional Water Quality Council should encourage and monitor ongoing studies on this problem and seek to have management practices identified which would best control erosion and brine leaching from brine-spill areas. The council should also monitor studies of the nature and magnitude of ground water contamination due to salt water intrusion being conducted by the Illinois Environmental Protection Agency and the Illinois Department of Mines and Minerals.

Petroleum exploration permits should be reviewed by the Regional Water Quality Council and comments made in regard to the effect these activities may have on water quality.

Implementation Goals and Funding

These recommended activities would commence in the first year of Regional Water Quality Council activity. These are the monitoring of current research into the effects of salt water intrusion on ground water, review of exploration permits and the monitoring of Rayse Creek, Little Muddy River, Rector Creek, Cone Creek, Crawford Creek, the North fork of the Saline River, the Middle Fork of the Saline River, Ewing Creek and the Big Muddy River for chloride ion concentration downstream from oil fields.

The first two of these activities would be part of the regular activities of the council and come under their operating budget. The chloride monitoring project would be an on-going responsibility of the IEPA carried out as a continuing planning process project funded from state or federal 208 monies. A cost of $3,400 per year has been estimated for this project.

By 1983 the inventory of salt damaged areas and the companion study of the effect of erosion from these areas on water quality should be completed. This activity would be the responsibility of the Regional Water Quality

Council and principally a concern of the Soil and Water Conservation Districts. Funding for these projects would be from 208 monies as part of the continuing planning process.

Methods for dealing with the special erosion and leading problems should be developed in a 3 year study and demonstration project. This project would at least be under way by 1983. It could be contract project under the funding of the 208 continuing planning process. Costs of this project over the three years are not fully predictable until it is known what structures or heavy equipment may be needed, however, over the three year span personnel equal to two half time position plus travel, mapping, and related costs are estimated at $79,000. Since several small demonstration projects would be needed and some use of heavy equipment and structures is likely total costs over the three year span could go well over $100,000 for this project.

The overall implementation goal of these programs is to show a decrease in chloride concentration in affected streams by 1985 that is attributable to the efforts carried out as a result of 208 water quality management implementation. As a secondary goal methods for dealing successfully with areas of soil contaminated by salt brine spills will be demonstrated, described and documented.

Chapter 3

SILVICULTURE

Silvicultural activity is all activity associated with growing and harvesting a forest. Some of the activities falling under this general heading are regarded as potential causes of nonpoint pollution to surface waters in or flowing out of forested areas.

Various activities which are part of "silviculture" have been rated according to their potential to adversely impact water quality.[7] Those having a high potential rating were building and use of logging roads, building and use of log landings and loading decks, and conversion of forest land to other uses. Activities having a medium risk rating were disposal of slashings, preparation of planting sites, application of pesticides and grazing of forests. Harvesting activities (except use of logging trails), timber stand improvement activities, and fertilization were considered low pollution risks.

Silvicultural activities in the 208 area occur on privately-owned lands and within the Shawnee National Forest. Private land operations are usually small, encompassing less than 50 acres. Commercial tree harvesting within the Shawnee National Forest is well documented, but private land owners are not required to report sale or harvest of trees. Because of this, records of these operations are lacking. It has been estimated that about 30% of potential commercial forest in the 208 area is in Shawnee National Forest, while 70% is under private ownership. Figure 5 shows the extent of national forest lands in the ten county 208 area.

Since only national forest harvest and sale is reported, it is not possible to quantify past tree harvest in the 208 area. It is estimated that as much as 8,000 acres of privately-owned land may be affected each year by silvicultural activities leading to tree harvest in the 208 area. Shawnee National Forest information giving acreages harvested when calculated on a per year basis gives 609.3 acres as the yearly acreage of affected lands. Future impact of silviculture in the 208 area is expected to concentrate in Hardin, Jackson, and Pope Counties.

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FIGURE 5
SHAWNEE NATIONAL FOREST LANDS
IN THE 208 AREA

NORTH

NATIONAL FOREST BOUNDARY

NATIONAL FOREST LAND

scale in miles

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION

The preparation of this map was financially aided through Federal Grant No. P005225-01 through the U.S. Environmental Protection Agency under the Water Pollution Control Act Amendments of 197

Impacts on Water Quality

Silvicultural impacts on water quality are thought to be very limited in the 208 area. Potential inputs of sediment, nutrients, pesticides, and organic enrichment from silviculture are put in perspective when forested acreages affected by tree harvest activities are compared with acreages affected by crop harvests and acres exposed through strip mining in the 208 area. In percentage of total acreage, these activities affected 0.3%, 29.0%, and 1.7% respectively.

The undisturbed forest floor has a high ability to absorb water. Only the most intense rainstorms cause runoff. Under ordinary circumstances, virtually no surface water flow takes place in the undisturbed forest. In the stream, erosion from the forest floor is found to be about half particulate matter and about half dissolved solids by weight. Channel erosion is thought to be the source of almost all particulate matter in forest streams and percolation of water through the forest floor is thought to result in the dissolved solids present.[8] Removal of trees causes a greater yield of water to the streams thus increasing channel erosion (Table 6). In forested areas of the 208 area, no violations of state water constituent levels for total dissolved solids or particulate matter were found that can be attributed to silvicultural activities.

Silvicultural practices which cause increases in sediment input to streams involve the break-up and/or removal of normal forest floor cover. The construction and heavy use of roads and logging trails, stream channel alteration, and construction of bridges and culverts may all produce increases in sedimentation to nearby streams. Erosion of roads is the greatest contributor to general sedimentation in forests. Well managed logging operations are expected to produce no more sediment in streams than undistrubed forest.[9]

Sedimentation is increased by improperly managed harvesting and by reforestration activities. Clear cutting is said to cause increased sediment transport for up to ten years.[10] If the forest is cleared and then converted to other uses an even greater sedimentation of runoff waters will occur. Timber stand improvement or limited harvest and reforestration activities cause small increases due to minor soil disturbance. The erosion potential of various types of disturbance has been evaluated in terms of tons per acre per year sediment loss in Michigan.[11] A portion of a table of potential sediment losses for Michigan forests is presented as Table 7. It represents areas judged most similar to Illinois forested areas.

Table 7
AVERAGE PREDICTED ANNUAL SOIL LOSS
AND SEDIMENTATION RATE IN FOREST
AREAS IN 2 REGIONS OF SOUTHERN MICHIGAN

Disturbance Type	Erosion	Sediment
WRC Subarea #409	Tons/Acre	Tons/Acre
Undisturbed	0.06	None
Managed Logging	0.06	None
Unmanaged Logging	0.72	0.07
Light Grazing	0.50	0.05
Heavy Grazing	2.77	0.55
Logging Roads	3.11	0.31
WRC Subarea #405		
Undisturbed	0.05	None
Managed Logging	0.05	None
Unmanaged Logging	0.53	0.06
Light Grazing	0.37	0.04
Heavy Grazing	2.04	0.49
Logging Roads	2.29	0.27

This table was adapted from Table 2, page 12, "Water Quality and Forest Land Use In Michigan, Report of The Ad Hoc Committee On Best Forest Management Practices for Michigan;" Michigan Dept. of Natural Resources, 1977.

Log landings and loading decks are areas where there is constant ground disturbance leading to sedimentation from tractors dragging logs, trucks, etc., plus accumulation of bark fragments, spilled fuel, and spilled oil.

Silviculture-related pollution of surface waters by fertilizers is not a problem in southern Illinois. Some fertilizer is used in production of Christmas trees. Amounts used are negligible.

Pesticides and herbicides are also not a pollution problem in forests of the 208 area. When they are used, most of the chemical material is tightly adsorbed on the organic/mineral soil complex and does not find its way into streams.

Increased stream bacterial counts due to heavy grazing in forest lands is a potential problem in the 208 area. This problem arises when grazing animals have access to streams.

Controls

There are no substantial water quality problems arising from silvicultural activities in the 208 area and future developments are not likely to produce any. However, there should be a continued awareness of potentials and attention to good management to assure that problems will not become substantial. To insure good management practices the activities of the IEPA Forestry Subcommittee of the Task Force on Agriculture Nonpoint Sources of Pollution should be monitored.

The most important control needs in the ten-county 208 area deal with sedimentation potential. In this category, the building and maintenance of roads needs the most attention since this activity destroys a portion of the water-holding layer of the forest floor. The following practices must be included in management of silvicultural activities to control erosion caused by the building of logging roads.

1. Road planning in conjunction with overall land use for the area with surface and ditching sufficient for type of traffic likely, and local climatic conditions.

2. Logging road construction and stream crossing construction confined to in low rainfall seasons.

3. Construction should fit the topography so that steep grades, cuts, and fills are kept to a minimum.

4. Stream crossing should be kept to minimum and protected from erosion by using rip-rap, concrete aprons, and large enough culverts, and by keeping structure cleared of debris.

5. Roads should be only as long as necessary.

6. Road drainage systems should be well planned and should discharge into stable forested areas not directly to streams.

7. Roads should be well crowned and graded to prevent rut formation.

8. Unused roads should be closed off.

Control of sedimentation and retention of natural stream temperatures requires attention to logging systems since substantial site disturbance and removal of shading canopy may occur when trees are harvested. Effective control measures include the following:

1. Number, length and gradient of skid trails should be minimized.

2. Skid trails across stream channels should be avoided.

3. If streams are crossed it should be where the stream bed is stable or on temporary bridges.

4. A streamside management zone should be maintained from which heavy equipment is excluded. The maintenance of such zone is an important need in the 208 area. Selective harvesting from this zone should be by use of winches and should be done in such a way that the stream remains shaded and low level streamside growth is not destroyed. The width of this zone can vary with the topography being wider in steep topography than in flat areas. The zone should be wide enough to assure that sediment will be trapped and nutrients in the runoff absorbed.

5. Waste and extra fill should not be dumped within the high water zone.

To control pollution by nutrient materials and by pesticides and herbicides the following practices must be followed:

1. Avoid use of fertilizer or pesticides and herbicides in the streamside management zone.

2. Applications of chemicals and fertilizers should occur only after a needs analysis shows them to be required.

3. Indicated amounts of chemicals and fertilizers should not be exceeded.

4. Aerial applications of chemicals and fertilizers should avoid distribution directly into streams via fly overs or wind drift.

5. Fertilizer application should be in the budding season when maximum uptake will occur.

6. Materials should be stored in such a way that spills and leaks will not occur.

Other control measures are necessary to prevent or minimize silviculture related degradation of water quality. The following have particular importance in the 208 area:

1. Grazing and holding of livestock in forested areas may ruin the woodlot for forest production. Animals should be fenced out of forested areas entirely or allowed very limited access for drinking purposes.

2. Forested land in forest areas should not be converted to other uses.

3. If such a conversion is made, it should be after an erosion control plan has been drawn up and provided for using professional assistance.

4. Abandoned or marginal crop production lands should be converted to forest.

Management of silvicultural operations in Shawnee National Forest should be the responsibility of the U.S. Forest Service. County Soil and Water Conservation Districts should enter into an inter-local agreement with the Illinois Division of Forestry, with respect to management of silvicultural activities on privately-owned wood lots.

Implementation Goals and Funding

Preparation and/or distribution of educational materials covering best management practices used in tree harvest and in the construction of logging roads should commence during the first year of 208 management plan implementation. Both of the U. S. Forest Service and the Illinois Division of Forest should be involved in this.

A co-management agreement between the Illinois Divison of Forestry and the County Soil and Water Conservation Districts should be in operation during 1979 so that these entities can be instrumental in an education project designated to reach landowners with privately owned forest plots 1980 as a means of encouraging use of silvicultural BMP's on private lands on a voluntary basis.

A total 10-county cost of $16,000 per year in salary and travel is estimated for this program. If mandatory programs must later be instituted costs would incluce monitoring and inspection. These costs would be much higher.

Enforcement of recreational vehicle restrictions in stream side management zones would begin at the onset of the implementation phase of the management program in public lands and only if mandatory controls are called for in private lands. No mandatory program would begin before 1985.

Chapter 4

CONSTRUCTION RELATED TO NONPOINT POLLUTION

Construction which has potential for impact on water quality generally includes projects dealing directly with water courses, projects related to coal mining, construction related to outdoor recreation, construction related to non-urban industry, construction at residential development sites and construction projects related to transportation.

Of these water course projects, residential development projects, mine-related projects, and transportation projects are of current and/or foreseeable future importance in the 208 area in terms of size, scope, and time span.

Transportation projects that have potential for water quality degradation are those which involve exposure of bare earth to wind and to rainfall runoff. Many transportation construction projects (resurfacing of paved roads or bridge redecking, for example) present no known water pollution hazard. Those which do present a pollution hazard include new road construction, road widening, new bridge construction, placement of culverts, construction of interchanges, addition of lanes to existing roads, and construction of rest areas. All of these are among projects that were in progress and/or in planning stages during the 208 water quality monitoring projects.

Of these activities, the greatest potential for water quality degradation rests with new road construction and bridge and culvert construction. The first of these has great pollution potential because large areas of earth are laid bare in base construction and remain barren for some time. Bridge and culvert construction is more localized, but has high pollution potential because of the proximity of the work to flowing streams. Table 8 gives the number of each type of project in progress or planned for the ten county 208 area considered to have water quality degradation. Road construction, culvert installation, and bridge building projects in progress during the 208 water sampling program which affected streams being monitored are located on the map shown as Figure 6.

Table 8
TRANSPORTATION RELATED CONSTRUCTION IN THE 208 AREA

Fiscal Year 1976 & 1977

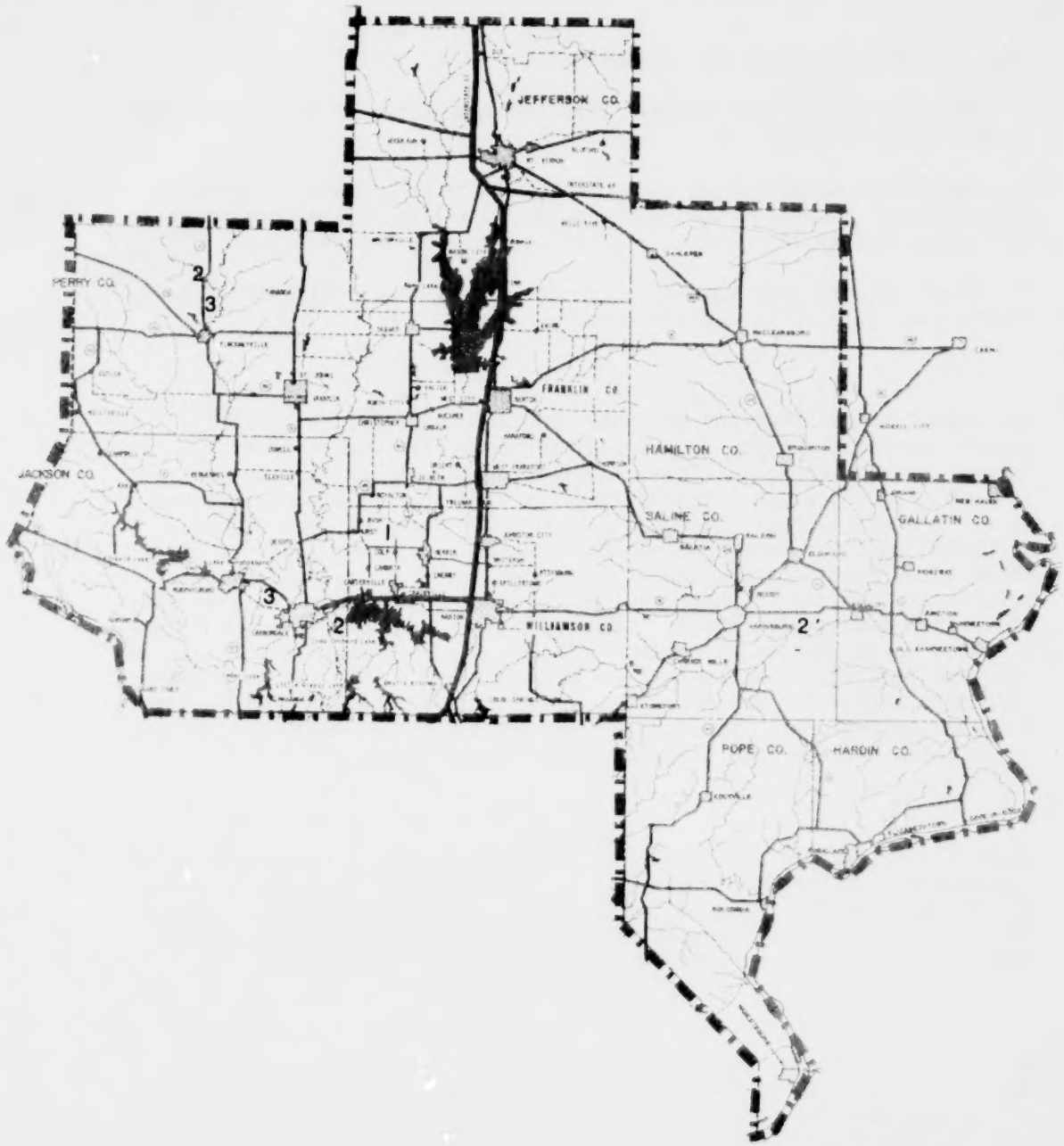
Type of Work	Number of Projects
Bridge construction	50
Placement of culverts	4
Road widening	7
Road reconstruction	12
Landscaping	2

Fiscal Year 1978 Projection

New road construction	2
Bridge construction	12
Placement of culverts	1
Road widening	1
Landscaping	2
Roadside park & recreation area	1
Interchange construction	1

Source: Illinois Department of Transportation, Proposed Improvements For Illinois Highways, Fiscal Years 1976-77-78.

Figure 6
PROJECTS IN PROGRESS DURING 208 WATER SAMPLING PROGRAM



1. Multiple Culvert Installation
2. Bridge Construction
3. Road Widening & Base Construction

NORTH

scale in miles

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION

The preparation of this map was financially aided through Federal Grant No. P005225-01 through the U.S. Environmental Protection Agency under the Water Pollution Control Act Amendments of 1972.

These projects include the following:

1. New multiple culvert installation and approaches at Hurricane Creek in Williamson County.

2. New bridge construction on highway 127 crossing Swanwick Creek in Perry County. Near the Crab Orchard Lake spillway at the Jackson-Williamson County line and on the Saline River in Saline County.

3. Road widening with some new base construction on route 127 in Perry County and route 13 in Jackson County.

The impact of construction projects upon water quality is basically one of increased erosion from the disturbed area. The greatest pollutant is suspended and settleable solids. The particles moved to streams from disturbed sites may vary in size from 0.1 to 100 microns in size. The smallest of these would have a settling velocity of about 0.0000015 centimeters/second and the largest a settling velocity of about 10.00 centimeters/second. The range goes from particles that settle very rapidly to those that will stay in suspension for virtually the entire course of a river. High rainfall runoff conditions will give a stream large amounts of erosion input from a construction site and at the same time insure a level of velocity and depth that can spread the suspended materials far downstream. Much of the suspended solids load will not settle until it enters a reservoir. Here it will contribute to the problem of reservoir capacity loss through siltation.

When silt settles in quiet waters along stream courses, the covering of the natural substratum may limit or kill bottom dwelling animals which act as food for fish. Suspended particles reflect and absorb sunlight. This limitation of sunlight entering the stream will decrease photosynthesis and alter energy transfer in the whole ecosystem.

When a portion of the temporary dirt fill and culvert crossing of the Saline River middle fork eroded away at a bridge construction site, much of it must have been added to the deep accumulation of mud already covering the river bottom at Equality, downstream where water velocity slows.

To properly assess the effect of construction projects, data is needed showing the daily input of suspended solids just downstream and just

upstream of the disturbed area during construction. No such data exists for the 208 area.

No state water quality standards have been set for the 208 area for suspended or settleable solids. The standard for total dissolved solids is 1000 mg/l. Soil erosion from construction sites could be expected to increase both of these parameters, but both effects would be short-lived and limited to periods during and for a short time after sufficient rainfall.

Average suspended solids and total dissolved solids figures are given in Table 9 for 208 water quality monitoring sites up and downstream from two road projects and two bridge construction projects and downstream from one bridge and one culvert and approach construction project.

Table 9 shows no great increase of suspended soils or total dissolved solids due to erosion from any of the construction sites. One or more of three factors make this a non-conclusive index of the effect of these projects in each case. They are: the great distance from the construction site to the water sampling sites (as in items 4 and 5, Table 6); the lack of samples taken at peak erosion times (true of all examples given in Table 6);and the size of the background suspended and dissolved solids load due to agricultural and/or mining activities upstream from the monitoring sites (as in examples 1, 3, 4, and 5, Table 6). These figures show nothing conclusively except the need for some localized studies designed to assess sediment in streams due to specific types of construction projects.

Residential development sites also have great potential for localized erosion problems. There are often long periods of time when lots are graded and standing idle awaiting construction starts. Street base construction often stands idle for long periods of time before paving, curbing, and guttering construction stages commence. Even on relatively gradual slopes erosion of sediment to streams could be substantial from such areas while barren or grown up in the scattered weeds that are typical on soils of poor fertility.

A study should be made of the impact of various types of projects by establishing continuous monitoring of suspended and dissolved solids

Table 9
AVERAGE VALUES FOR TWO PARAMETERS OF
POTENTIAL INPUT FROM CONSTRUCTION SITES

(See Figure 1 for Locations)

Project	Monitoring Site		Average Suspended Solids	Average Total Dissolved Solids
1. Hurricane Cr. Culverts	NF-01	before project	25.5	990.6
		after completion	12.8	1082.5
2. Crab Orchard Cr. Bridge	ND-02	before project	7.0	255.0
		during work	13.0	374.0
3. Saline River bridge	AT-06	upstream	42.3	1629.4
	AT-05	downstream	54.0	1515.5
4. Route 127 road & bridge	NC-08	upstream	48.2	723.9
	NC-10	downstream	55.0	469.5
5. Route 13 road construction	NE-03	upstream	131.6	952.1
	N-09	downstream	108.0	563.1

Source: From data collected by Greater Egypt Regional Planning and Development Commission Staff.

above and below areas of disturbance before, during, and after construction. Such a study could also provide information about the effectiveness of the erosion control measures normally taken at such construction sites.

Control measures at construction sites should serve to minimize soil exposure, control surface water runoff, shield exposed soil, and/or bind exposed soil. Channel changes should be avoided except when proven to be absolutely necessary to accomplish the project's purpose.

Control measures at road and bridge sites usually fit one of the following categories:

1. Surface roughening
2. Interception and diversion
3. Vegetative soil stabilzation
4. Non-vegetative soil stabilization.

Common control practices that are needed at road, bridge and culvert construction sites in the 208 area include these:

1. Stacking of straw bales to prevent rill erosion by retarding flow velocity
2. Mulching with straw or hay
3. Seeding with grass or spreading herbaceous plants
4. Seeding and mulching
5. Seeding and mulching held by staked netting
6. Planting of shrubs and trees
7. Ponded detention of water to allow settling of solids.

The Illinois Department of Transportation and the respective county governments should require the application of these practices wherever appropriate to reduce erosion from road, bridge, and culvert construction sites.

Management of potentials for water quality degradation related to residential development sites should be the responsibility of local governments. County-wide planning, zoning or subdivision ordinances should be used by local governments as a tool to govern location and rate of development. Such ordinances and regulations should require that topographic features and erosion potential of soils be taken into account in street construction and lot layout, so as to minimize erosion problems. Timetables for paving and guttering streets and revegetation of barren land should be specified. An inventory of soil characteristics in regard to comparative erosion rates should be required and soil percolation tests taken by health department officials before development, so that erosion prevention measures and private sewage disposal requirements (where there is no sewerage) can be prescribed as part of pre-development planning.

Implementation Goals and Funding

Erosion control practices and shielding and binding of exposed soil at road construction and other transportation project sites should be an integral part of every project contract from the beginning of the implementation phase of 208 Water Quality Management. This is principally the responsibility of the counties and Illinois Department of Transportation. It is funded by them through inclusion of these practices in contract requirements and monitored by them through their responsbility to assure that contract requirements are properly met. Basically these provisions have been implemented prior to 208 planning. They should continue with closer monitoring to assure that practices are put in place without delays and in prescribed manner from the beinning of the implementation phase of 208 Water Quality Management.

Erosion control and shielding of exposed soil would also be built into requirement for residential development projects as part of 208 Water Quality Management. Implementation of zoning and subdivision ordinances should commence in the counties and subdivisions of the 208 area on or before the second implementation phase beginning in 1985.

The costs of implementation and enforcement would be met by local governments and would vary considerably from place to place. An estimated average per county cost for implementation and enforcement in the 208 area is $15,600 per year. Much higher costs would accompany the initial development of an ordinance, however this work has been done in the region as a 1969 project by the Greater Egypt Regional Planning and Development Commission and need not be repeated.

Subdivision ordinances would require management practices to control erosion and stabilize exposed soil during subdivision construction projects. Project planning would take into account the soil types and topography of the area to be developed. Costs of these activities would be picked up by the contractors dealing with the appropriate project phases.

Chapter 5

HYDROGRAPHIC MODIFICATIONS

Hydrographic modifications treated here will include the impoundment of flowing waters, channelization of streams with associated clearing and construction, diversion of streams around areas of surface mining, and other activities which alter the natural direction, configuration and velocity of flow or the nature of stream beds and banks.

Impoundment of water occurs when a structure of earth; earth and concrete; or earth, concrete, and wood is placed perpendicular to flow, causing retention of water in a pool upstream from the structure. This is a common practice in the 208 area. As a result, forty two (42) public impoundments of more than ten surface acres are found in the 208 area, with additional impoundments in the planning stages. Many more privately owned impoundments of various sizes are found in the area. However, not all of these exist as segments of streams. Most are points of rainwater runoff collection in tributary headwater reaches of stream watersheds.

Public impoundments are constructed to create a reliable source of water for public consumption, as recreational waters, and as a flood control device. Not many of the 42 area public impoundments are now used as public water supply sources, but that was the original use.

Channel straightening and deepening is usually accompanied by clearing of trees and shrubs and the building of dikes where banks are not high. The stream bed may also be dredged deeper. These hydrographic modifications are most often used to prevent flooding in the immediate area of the project and to facilitate drainage of wet lands so they can be put under cultivation.

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Stream diversion is a means of changing the location of a stream bed when it is a problem to an activity to be carried out in the area. Diversion is most commonly carried out in the 208 area by coal mining companies which seek to send stream waters around the perimeter of areas to be surface mined. If this were not done, surface mines would have to stop at natural stream banks to prevent streams from emptying into the surface mine pits during operations.

Potential for pollution of streams during and after these modifications are complicated and variable and is affected by such factors as topography, climate, soil type, type and density of vegetation, and land use. The general effects of these hydrographic modifications on stream flow, physical characteristics of the water and water quality, as they would be expected to occur in the 208 area are given in Table 10.

Once in place and if structures are sound, impoundments do not pose a pollution threat. They create an enlarged area of slow or standing water and aquire changed biotic communities adapted to higher surface water temperatures, accumulating soft substrata and seasonal changes in the chemistry, temperature, oxygen stratification and nutrient content of water and substrata. Impoundments tend to act as a biodegradation tank for organic pollutants and settling basin for suspended materials thus improving the quality of water between inflow and outflow.

Stream channel alterations can be a wide range of activities from minor to drastic in scope. Snagging and clearing of instream obstructions following the natural channel has little impact on water quality. However, clearing, excavation, and straightening can have much adverse effect on water quality especially if bank vegetation is not restored and if oxbows are cut off.

Stream diversion has potential for the same effects as channelization since the resultant ditch is quite similar. However, the stream is not usually shortened or speeded up in flow to the extent that it is in channelization. Some mine operators return drainage to the original pattern during reclamation, hence stream relocations may be temporary in some cases.

Table 10
THE GENERAL EFFECTS OF THREE TYPES
OF HYDROGRAPHIC MODIFICATIONS IN THE 208 AREA

	Type of Modification		
Effects Expected in 208 Area	Impoundment	Channelization	Diversion
Erosion during construction	X	X	X
Continuing erosion input		X	X
Silt accumulation	X		
Increased water temperature	X	X	X
Increased flow velocity		X	
Decreased flow velocity	X		
Alteration of natural habitat	X	X	X
Changes in biotic communities	X	X	X
Changes in bordering land use	X	X	X
More rapid downstream transfer of water quality problems		X	
Concentration of sediment pollutants	X		

Source: Greater Egypt Staff

In both channelization and relocation, the greatest visible degradation of water quality takes place during the construction phase. However, poorly planned and/or improperly executed projects will continue to create water quality and maintenance problems. Some adverse effects on water quality can never be alleviated once a large channelization project has been completed.

Table 11 lists the public impoundments currently in each county in the 208 area. Two new impoundments of relatively large scale have been proposed for the 208 area. They are the Ten Mile Creek project near McLeansboro in Hamilton County and the Little Saline River project in Saline Pope, and Johnson Counties near Stonefort and Eddyville. These are located on the map in Figure 7.

Also marked in Figure 7 is the location of the Smithland lock and dam under construction on the Ohio River.

The major channelization work in the 208 area is the channelization and clearing project on the Saline River. The location and extent of this project is shown on the Figure 7 map. This project includes 51.9 miles of channelization on the Saline River middle fork and north fork and 15.4 miles of clearing on the south fork and north fork of the Saline River. The channelization (straightening, widening, and deepening) of the Saline and its major tributaries was completed in 1970. Clearing of the previously channelized South Fork of the Saline River will be completed in the near future.

Table 12 gives the names of mines that have included stream diversion in plans for surface mines now under permit and tells the location of the mine and/or the diversion project.

The scope of hydrographic modification activities in the 208 area has shifted away from reservoir construction since the construction of Rend Lake and Lake Kinkaid. These projects, completed since 1969, are used as the major water supply reservoirs in the 208 area. The Smithland lock and dam project which has been underway since 1971 is basically a transportation project. It will raise the Ohio River 22 feet at the dam

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Figure 7
PROPOSED HYDROGRAPHIC MODIFICATIONS IN THE 208 AREA

Table 11
PUBLIC IMPOUNDMENTS

Name	Surface Acres
FRANKLIN COUNTY	
Benton Lake	67.6
Buckner City Reservoir	16.5
Christopher Old Reservoir	19.8
Christopher New Reservoir	37.8
Hamilton Lake	34.2
Moses Lake	170.0
Rend Lake (Part in Jefferson County)	8,878.0
Sesser Lake	42.5
West Frankfort Old Reservoir	146.0
West Frankfort New Reservoir	214.0
Ziegler City Reservoir	50.0
TOTAL	9,676.4
GALLATIN COUNTY	
Pounds Hollow	25.6
Omaha City Reservoir	22.0
TOTAL	47.6
HAMILTON COUNTY	
Dolan Lake	71.3
McLeansboro New Reservoir	75.0
TOTAL	146.3
HARDIN COUNTY	
Lake Tecumseh	13.0
Whoopie Cat	26.6
TOTAL	39.6
JACKSON COUNTY	
Lake Murphysboro	144.0
Kinkaid Lake	2,675.0
Cedar Lake	1,750.0
Carbondale City Lake	58.5
Little Cedar Lake	84.0
TOTAL	4,711.0
JEFFERSON COUNTY	
Jaycees Lake	91.9
Mt. Vernon City Reservoir	130.0
Rend Lake (Part in Franklin County)	10,022.0
Waltonville Lake	15.5
TOTAL	10,258.4
PERRY COUNTY	
Pyramid State Park	134.7
DuQuoin Reservoir	183.0
Pinckneyville Reservoir	165.0
TOTAL	482.7
POPE COUNTY	
Lake Glendale(U.S.F.S.)	82.0
One Horse Gap Lake (U.S.F.S.)	26.0
Bay Creek #5	118.0
Bay Creek #8	96.0
TOTAL	322.0

Table 11 (Cont'd.)

Name	Surface Acres	Name	Surface Acres
SALINE COUNTY		WILLIAMSON COUNTY	
Glen O. Jones	105.0	Crab Orchard Lake	6,910.0
Eldorado City Reservoir	97.8	Devil's Kitchen Lake	810.0
Harrisburg Borrow Pit	18.5	Herrin New Reservoir	46.1
Harrisburg Lake	208.9	Herrin Old Reservoir	51.3
Harrisburg North Reservoir	31.1	Johnson City Reservoir	59.2
Harrisburg South Reservoir	36.0	Little Grassy Lake	1,000.0
		Marion Reservoir	220.0
		Lake of Egypt	2,250.0
TOTAL	497.3	TOTAL	11,346.0

Source: Greater Egypt Staff, with assistance from U.S. Department of Agriculture, Forest Service, Shawnee National Forest, Harrisburg.

and replace two older navigation pools. Water backup in the Ohio will raise the Saline River upstream beyond Equality. The project will be completed by 1980. The tentative 1,910 acre Ten Mile Creek Lake and the proposed Little Saline River Lake will be used as water supply/ recreation lakes for McLeansboro and Harrisburg respectively if they are built.

Table 12
CHANNEL DIVERSION PROJECTS IN 208 AREA SURFACE MINES

Mine	Stream	Permit Date	Location
Leahy Mine (Amax)	Pipestone Creek	7-1-76 to 6-30-79	S25, T6S, R4W Perry
Burning Star #2 (Consol.)	Beaucoup Creek	7-1-76 to 6-30-79	S12, T5S, R3W Perry
Burning Star #5 (Consol.)	Little Muddy Creek	7-1-76 to 6-30-79	S10, T8S, R1W Jackson
Captain Mine (S. Western C.C.)	Galum Creek	7-1-76 to 6-30-78	S18, T6S, R3W Perry
Fidelity #11 (Freeman United)	Panther and Little Beaucoup	7-1-76 to 6-30-79	T6S, R2W Perry

Source: Illinois Environmental Protection Agency, Permit Applications

The impact of water impoundment projects upon water quality is a positive one in terms of the usual parameters used to evaluate water quality. Sediments settle out taking heavy metal precipitates with them, pesticides settle with the sediments and move into the food chain (as do heavy metals) but do not contaminate outflow water equal to the contamination of specific inflows. Sewage, other nutrient inputs, and organophosphate insecticides are biodegraded by action of bacteria, plants, and animals in the reservoir usually relatively near the point at which they enter as seen in the I.E.P.A. Crab Orchard Lake Study in 1976. Badly polluted water can be spread over a long distance in a flowing stream, but improve in quality over a relatively short distance in an impoundment. Conversely if the capacity of the impoundment to process nutrients is exceeded, blooms of nuisance organisms can make use of the

impounded waters by man difficult. Quality improvement is the result generally expected when water is impounded in the 208 area. This fact is well illustrated when 208 water quality monitoring data from station ND-05 upstream from Crab Orchard lake is compared with data for the same parameters over the same time span a short distance downstream from Crab Orchard Lake (Table 13).

The deepening, widening and/or straightening of stream channels has varying degrees of negative impact upon water quality in the stream.

Streams in the 208 area most commonly flow through terrace or bottomland hardwood forest or through agricultural lands with hardwoods bordering on the stream banks. Long segments of channelization and bank clearing such as that done and proposed in the Saline River basin has the potential for severe and lasting negative effect on water quality. There are positive effects related to land use and agriculture, but these results are sometimes purchased with the price of problems created up and downstream.

Positive effects of channelization in the 208 area include improved drainage of some established croplands, increased crop and pasture yields, improved septic capability of some soils, and opening of land for crops, housing, and industry. Negative effects will be dependent upon the extent of work done and the kind of lands present in the immediate area. Where trees and brush are removed, the resultant loss of canopy and shade causes raised water temperature and increased sunlight input to the stream. These changes alone lead to drastic changes in the biological aspects of the stream ecosystem. If wetlands are drained the natural water balance is upset, reduced detention of subsurface moisture occurs, evapo-transpiration rates are reduced, and land systems are no longer resupplied by overbank floods. These effects lead to changes in naturally occuring plant species and to a general drying of forest floor. When natural growth is removed, the reduction of available cover and forage for wildlife causes concentration of these populations elsewhere and leads to increased forest stream fecal coliform counts, and increased feeding on farm crops by wildlife.

Channel straightening speeds runoff. This has the effect of reducing local flooding, but also causes increased downstream sedimentation and more rapid transfer of other water quality problems from their source to major waterways and reservoirs. If banks are not replanted, bank

Table 13

MONTHLY AVERAGE 208 WATER QUALITY MONITORING RESULTS FOR FOUR PARAMETERS IN CRAB ORCHARD CREEK ABOVE (ND-05) AND BELOW (ND-02) CRAB ORCHARD LAKE OVER A 4 MONTH PERIOD IN 1976

(all figures are mg/l)

Month	Monitoring Site	Total Fe	Sulfate	TS/ROE	Suspended Solids
July	ND-05	1.0	600.0[X]	996.7	12.7
	ND-02	0.16	116.7	608.0*	16.7
August	ND-05	2.53[X]	199.7	404.0	63.7
	ND-02	0.18	82.5	237.3	7.3
September	ND-05	0.93	322.5	835.0	14.0
	ND-02	0.00	105.0	278.3	9.0
October	ND-05	0.43	525.0[X]	875.0	11.3
	ND-02	0.20	116.3	298.3	15.8

Legend

Total Fe - total iron
TS/ROE - total dissolved solids
* Includes one questionably high entry
[X] Above state standard for this parameter (Fe standard = 1.0)

Source: From data collected by Greater Egypt Regional Planning and Development Commission Staff

erosion will continue to increase loads of suspended solids and dissolved solids. In the Saline River system acid mine drainage pollution and agricultural input are carried quickly over long distances in the straightened, deepened, widened channels.

The effects of channelization (straightening and deepening) were summarized by Wyche[12]. He determined that channelization efforts disrupt the stability of grade found in undistrubed streams. In undistrubed streams this state of equilibrium established with its discharge, load and base level will result in stabilized aquatic communities and predictable long-range responses of the entire stream to seasonal runoff and other natural variables.

Interference with this equilibrium by channel straightening and deepening operations will cause a state of instability and start a series of processes tending to reestablish natural stability. These processes will be evidenced by (1) increased degradation of upstream reaches; (2) increased channel roughness; (3) return to meandering; and (4) natural revegetation of banks.

At the downstream end of the channelized portion the stream will aggrade as load begins to exceed carrying capacity. Attempts to prevent a return to meandering through use of revetments or rip-rapping will cause the stream to attempt to stabilize its grade by even greater rate of downstream aggradation and upstream degradation. The result will be erosion problems in upstream reaches and excessive siltation at the lower end of the channelized segments. Continuous intervention in these processes would be required to keep the stream from eventually returning to a stable condition by the processes of upstream degradation, downstream deposition, floor roughening and meandering.

Channelization can be costly both in terms of increased erosion of upstream land areas and the necessity to periodically dredge, restraighten, and install stabilizing structures. These costs must be balanced against the expected benefits of a channelization proposal before the real cost/benefit ratio for such a project can be known.

The upper watershed erosion caused by channel straightening, deepening and widening has been documented in a study of the Blackwater River in Missouri by Emerson[13]. In the Blackwater River watershed, a channelization

project carried out 60 years before the study led to diversion of 53.6 km of the river to a straight, deeper parallel channel 29 km long. The gradient was nearly doubled.

The channel has increased from a cross sectional area of 38 square meters when first dredged to a present range of 160 to 484 square meters. Dredged portions of tributaries have similarly widened showing that extensive bank erosion has taken place. In addition unchannelized portions show headward erosion of gullies. Bridges on country roads have had to be periodically replaced with longer ones as erosion occurred over the years. In one location a 27 meter replacement bridge was itself replaced twelve years later. Five years after that, the third replacement bridge was constructed with a 70 meter span which had collapsed 23 years later due to bank erosion. The widening has averaged 1 meter/year and deepening 0.16 meter/year. The upstream degradation is still in progress and stabilization not yet reached as shown by the fact that meanders have not yet re-formed.

In addition, the abrupt decrease in cross-section at the downstream end of the channelized segment has increased flooding there. Flooding probability is also increasing in the lower channelized segment due to reduction of channel holding capacity by sedimentation which is slowly progressing upstream.

The effect of the Blackwater River Project on stream life is shown by fish production figures which even 60 years after channelization show only 51 kg/acre fish in the channelized portions compared with 256 kg/acre in unchannelized portions.

Where flood control concerns urban areas and large amounts of property loss and threat to life are at stake the experience of the Clinton River project at Mt. Clemen, Michigan, suggests an alternative to channel straightening and dredging which may eliminate the upstream degradation problem[14]. A cut-off canal to the receiving body of water was constructed with a control wier. The natural channel is left intact and allowed to carry up to near its capacity with additional flow diverted through the canal. Such a project is more expensive than simple channelization, but is probably more cost-effective if the cost of upstream erosion losses were taken into account. A lower cost alternative is use of a simple flood flow channel cut so that it has flow only when flood stage is reached in the natural channel[15].

Stream relocation in the 208 area can create increased sediment loads during and after construction as well as localized alternation of the stream ecosystem. Since these projects do not necessarily result in increased stream flow rate or decreased flow distance, the effects may be less pronounced than in stream straightening (channelization) projects. Vegetative cover is removed in relocation. This gives the same increased temperature and stream life alteration effects as in the case of channelization projects. It is likely that the land-use changes that required a stream bed relocation will have greater impact over a long period of time than the actual relocation will have.

As shown in Table 13, where violation of monitored water quality parameters occur in a main stream flowing into an impoundment, these parameters are likely to drop well below violation levels at the outflow from the impoundment. Channelization will tend to have the opposite effect - spreading pollutants along greater lengths of a stream system. This is shown when data for monitoring sites on a channelized stream are compared with monitoring sites of equal distance from each other on an impounded stream (Table 14 and Table 13). In this comparison, note the increase in suspended solids from the upper to the lower segments of the mostly channelized portion of the Saline River. Nearly 20 miles of channelization occurs upstream from Station ATG-03 and approximately 16 more miles between ATG-03 and AT-04. The data for AT-04 also reflects input from the south fork and the north fork of the Saline River, both of which are channelized. The south fork, however, was tree shaded and demonstrated less bank erosion problems during the monitoring period.

It should be noted that the violated parameters in Table 13 and 14 are parameters associated with mine-waste pollution.

A comparison of average temperature for Station ATG-03 in the channelized portion of the Saline River with that found for the same months in the shaded and unchannelized Beaucoup Creek reveals a difference of 6.7 degrees (Saline River = 83.1^{o} F July and August 1976, and Beaucoup Creek 76.4^{o} F July and August 1976). During the same months, a channelized but shaded portion of Bankston Fork averaged 77.3^{o} F.

Permits and Certification

The Illinois Department of Mines and Minerals Land Reclamation Division issues surface mining permits to coal mining companies. The applicant for a permit must submit an approved reclamation plan. The plan is subject to review by the pertinent county board(s) and possible public hearing before it can be approved. The reclamation plan must include acceptable procedures for drainage pattern restoration after mining and relocation of streams during the permit period.

Table 14
MONTHLY AVERAGE 208 WATER QUALITY MONITORING RESULTS
FOR FOUR PARAMETERS ON THE SALINE RIVER OVER A 3 MONTH PERIOD
(All figures are mg/l)

Month	Monitoring Site	Total Fe	Sulfate	TS/ROE	Suspended Solids
July	ATG-03	2.45x	838.5	1341.8	74.0
	AT -04	5.43x	480.0	901.7	206.7
August	ATG-03	0.73	1016.7x	1956.7	25.0
	AT -04	1.82x	702.5	1242.5	61.3
September	ATG-03	0.37	1037.1x	2031.4	11.0
	AT -04	0.97	700.0	1398.3	35.7

Legend

Total Fe - total iron
TS/ROE - total dissolved solids
x Average above standard for this parameter

Source: From data gathered by Greater Egypt Regional Planning And Development Commission and staff.

Certification is required for hydrographic modifications involving flowing streams. Under section 404 of P.L. 92-500 and section 67 of PL95-217, both U.S. Corps of Engineers and state approval is needed for each instance of certification. States can veto projects allowed by the corps of engineers.

Structural Controls

Water impoundments are not a threat to water quality in the 208 area. In fact water retaining structures of various kinds are one means of improving water quality hence the dams which create impoundments may be considered a form of structural water pollution control. As seen in Table 13, this can be true for iron and for various dissolved solids and for suspended materials. Variations on the water retention structure concept are used to help solve problems related to channelization as well. Dams for upstream storage and smaller in-channel retention structures help restore natural soil water balance where water table draw-down results from channelization. Grade stabilization structures and sediment traps plus use of rip-rap and possible use of concrete floor and walls in critical segments will reduce on site bank and floor erosion. These precautions in place above in-stream reservoirs on channelized streams will retard siltation and extend the useful life time of the reservoir. Structures to hold tributary drainage to channelized streams will make the water table more controllable and help prevent sporadic events of rapid bank erosion.

Erosion Control

Erosion of channel banks along both channel straightened and relocated streams is retarded by planting of grasses. Full revegetation with brush and trees would make stabilization of banks and adjacent land equal to that of a natural stream. It would also lower water temperature, provide natural stream levels of light energy input, and return wildlife cover and forage that was lost.

Slowing Flow

The council on environmental quality report on channel modifications advocates maintenance of flow in cut off oxbows as a means of partially slowing high water flows. Where straightening has occured allowing a

natural return to meandering will decrease low and moderate flow velocities. In many cases stream straightening is not necessary to prevent local flooding and facilitate cropland drainage. Clearing stream beds of snags and debris may be sufficient.

To Summarize:

1. Impoundments are themselves a control measure to the extent that they act as a trap for sedements and a point of dilution for the most polluted tributory streams.

2. Various retention structures help alleviate the in channel erosion problems associated with channel modification. These include grade stabilization, sediment trap, tributary impoundment, rip-rap, and bank wall structures.

3. Restoring streamside vegetation (especially native brush and trees) will virtually stop movement of bank and adjacent soils to streams.

4. Following original stream contours with stream bed clearing activities minimizes flow rate increase, effect on natural water balance, and wild life habitat disturbance. However, channel alterations should be permitted unless it can be proven that (a) there would be no adverse effects on fish, wildlife and forestry resources, and (b) no other feasible alternative exists[16].

Control Implementation

County Soil and Water Conservation Districts, in cooperation with County Agricultural Extension Services should carry out a project of public education based on the latest findings concerning the effects of channel modification. This program of education should reflect the actual cost of such projects in terms of erosion losses to upstream watershed acreage, cost of application of needed soil management practices and structures, and costs of projected clearing, dredging and other work that will be needed to counter the stream's attempts to stabilize through agradation, degradation, floor roughening, meandering, and revegetation. Realistic cost/benefit figures should be developed taking these things into account.

The public should also be informed in this education program of the effects of channelization on aquatic life and what can be done to

restore aquatic habitat in channelized streams. The Illinois Department of Conservation, Division of Fisheries should assist this project with research results, new and from the literature.

Where proven hazards to public health or to valuable properties justify modifications for flood control, auxiliary channel for flood flow channel projects or other alternatives which are less likely to cause upstream degradation should be given primary consideration in lieu of channel deepening and widening projects. The Regional Water Quality Council should monitor the consideration of alternatives through the 404 permitting process.

Where channels have been straightened, no activities designed to deepen the channel, to prevent a natural return to meandering, or to mitigate aggradation should be allowed until upstream erosion control measures and bank revegetation along modified portions either are satisfactorily in place or are provided for in specified critical erosion areas of the watershed tributary to the site. Soil and Water Conservation Districts should coordinate with appropriate agencies, with respect to timetables, sequences, and priorities for these activities.

Under the guidance of the Soil and Water Conservation Districts such measures as headwaters and upstream impoundments, sediment traps, structures to hold tributary drainage, and grade stablization structures be put in place where deemed necessary in the watersheds of streams that have been previously channelized.

The appropriate state agency (Illinois Environmental Protection Agency, Illinois Institute of Environmental Quality or Illinois Department of Mines and Minerals) would be responsible for monitoring the implementation of surface mine reclamation plans, in order to assure that drainage patterns are in fact being restored after hydrographic modifications have been performed pursuant to mining operations.

The Regional Water Quality Council, in conjunction with state administrative agencies and the U.S. Army Corps of Engineers, review and comment upon permits issued under Section 404, as amended by Section 67 of the Clean Water Act of 1977, with particular attention to the disposal of dredge and fill materials and implementation of best management practices for erosion control in watersheds tributary to the site.

Implementation Goals and Funding

In the first year of Regional Water Quality Council activity review processes would be instituted that would enable the Council to have input in regard to hydrographic modifications pursuant to coal mining and projects that come under the 404 permitting process. The Council would exercise this review toward the purpose of limiting modifications that threaten water quality and aquatic habitat diversity in the 208 area.

By 1983 the recommended study of the effects of channelization projects in the 208 area on erosion rates, water quality and aquatic habitat diversity would be completed by Illinois Institute for Environmental Quality. This information plus documentation from the literature would become part of the public education effort conducted by Soil and Water Conservation Districts in cooperation with agricultural extension service.

Costs of the proposed research personnel, reconnaissance to establish sampling sites, travel equipment and water testing. The estimated total of $300,000 for this would be funded as a continued planning process with 208 monies.

The education effort drawing upon this information could be funded under the Clean Water Act of 1977 PL 95-217. Costs would vary according to the extent of the effort and size of the audience. Costs for a large one shot effort in the 10-county area could go well over $100,000. An implementation goal spanning the years 1981-1983 is envisioned for this project.

The requirement that erosion controls be in place in critical areas before channelization or channel redredging projects are authorized is potentially the most costly recommendation. Since critical erosion areas are specified, this implementation goal aligns with the agriculture goals for erosion control. Agricultural goals as established in Appendix B-2 Pollution Sources: Agricutlure calls for 33 to 50 percent land owner cooperation by 1983 among owners having critical erosion (ten tons soil loss per acre per year) acreage in those watersheds which include water supply reservoirs or impoundments with secondary water supply use capability. The cost of this soil management effort has been estimated at $5.8 million total of which $.87 million would be private funds and $4.93 would be from USDA, SCA and ASCS funds.

A more complete treatment of specified acreages may be required previous to allowing rechannelization projects with corresponding higher costs in those areas affected. The same funding sources would apply in these instances with possible changes in matching formula.

Chapter 6

RURAL SEWAGE

Rural sewage has considerable potential for pollution of 208 area surface waters. In this report, the term "rural sewage" is applied to small scale private sewage disposal installations of any type in unsewered rural areas which serve 15 person equivalents or less. (One person equivalent is equal to 100 gallons per day water consumption.) Nonpoint source pollution is often associated with these small scale private sewage systems. The most common type of private system is the septic tank connected with an underground seepage field. This type accounts for approximately 70% of all private systems in the 208 area of Southern Illinois.

Soils in the 208 ten-county area are very likely to have poor percolation qualities. This, coupled with seasonal high water table and the common problem of poor system maintenance, often leads to excessive ground seepage or even direct surface discharge of effluent from septic systems. This type of nonpoint pollution occurs in unsewered, unincorporated municipalities, rural subdivisions, and where there is rural housing along major highways. Such rural population concentrations are numerous in the 208 area and likely to increase with the increase in coal mining activities and the appearance of new industry such as the projected coal gasification plant at Cutler. One hundred fifty seven unsewered communities are found in the 208 area, of these 24 are in a 201 facility planning area.

Many septic systems in the 208 area are inadequate or not properly maintained. Health department officials estimate malfunctioning systems to be as many as 70% in the 208 area. In a Jackson County survey, 41% of the 4,274 septic systems surveyed were judged to be malfunctioning and 24% to need major repair or replacement.

Increased loading of septic systems occurs when piped water systems reach into unsewered areas. In Jackson County, there is potential overloading of 2,187 private systems due to extension of water pipelines into unsewered areas of population concentration.

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Poor maintenance practices account for much of the problem. Owners fail to have septic tanks pumped and inspected and sludge removed frequently enough. Entry of particles into the subsurface drainage field causes clogging and failure of that part of the system.

Many owners are unaware of the amount and frequency of maintenance necessary to keep septic systems operable or of the possible overloading of private systems when water districts supply rural areas. Health departments are understaffed and do not adequately carry out public education about private sewage systems and the public health consequences of pollution from failing systems. Existing ordinances are not rigorously enforced.

Other systems may suit the soil and groundwater conditions of the 208 region better, but money is not available to finance experimental systems testing. Instead, the emphasis is on construction of collection lines and large scale treatment facilities. These may not be the best approach to rural sewage problems because of the cost of sewage lines and their maintenance and the resulting increased flow of waste water directly into water courses. The Jackson County survey found 72% of the rural systems to be septic tanks, 9% oxidation lagoons, 7% sand filters, 7% outdoor privies, and 5% some other idsposal method. Sink and washing machine discharges are often poured directly out on the surface.

Poor maintenance can be a problem with other systems too. Accumulations of encrusting materials and vegetation can make circulating sand filters inefficient; lagoons can be silted in by erosion of embankments.

The rural sewage picture in the 208 area is replete with preventable nonpoint pollution problems. However, the extent and nature of these problems make them difficult or impossible to quantify in terms of pollutants entering water bodies. It would seem that when thousands of private systems are malfunctioning throughout the 208 area, some portion of the organic pollution of streams and sewage caused euthrophication of lakes and reservoirs is due to rural sewage input via surface runoff. This undoubtedly contributes to the degradation of water quality.

At Lake of Egypt, seepage from lake side septic tank systems has entered the water causing visible pollution effects. Here contamination of the reservoir can be traced directly to seepage from failing septic systems.

The new state private sewage disposal licensing act and code and related county ordinances should help bring about a decrease in pollution of surface waters by failing private systems. This can only occur, of course, with careful inspection and strict enforcement.

In the case of rural sewage pollution water quality degradation is accompanied by potential health hazards. Seepage into road ditches and surface depressions create breeding places for insects associated with disease such as the encephalitis carrying mosquito and contribute to airborn bacteria and viruses of human disease.

Polluted waters in reservoirs used for water sports such as swimming and water skiing can be a source for infections of the ear and other infections.

Prevention of pollution of surface waters by rural private sewage systems depends upon proper construction and maintenance, the education of owners, builders, and enforcement personnel to the consequences of rural sewage problems, and rigorous enforcement of existing codes and ordinances. Where mechanisms for these things do not exist, effective steps should be taken to provide for them. Following is a list of some specific measures that can apply.

Construction

1. Percolation tests at proposed subsurface field site to determine if alternate disposal methods are in order.

2. Coordination of zoning and sewage disposal permit systems where both are in effect.

3. Construction inspection by Illinois Department of Public Health in counties without health departments.

4. Licensing of contractors and designation of code of standards for design, materials, and construction.

Maintenance

1. Pumping and inspection of septic tanks every two years and removal of sludge before particles enter the seepage field.

2. Raking of circulating sand filters and removal of vegetation from them.

3. Proper inspection and maintenance of chlorination units.

4. Sodding and mowing of oxidation lagoon embankments.

5. Service contracts for maintenance of private disposal systems.

Education

1. Hold seminars and workshops to familiarize contractors and public health officials with soil survey information and the implications of soil types for choice of private disposal systems.

2. Public education emphasizing maintenance and the public health hazards imposed collectively by faulty systems. Alternative systems should be discussed and the benefit-to-cost ratio of correcting and properly maintaining systems.

3. Educate legal authorities on the scope of rural sewage problems to encourage more rigorous enforcement of laws and ordinances.

Laws and Enforcement

1. Adoption of private disposal ordinances in counties with county health departments.

2. Subdivision ordinances that establish standards for waste water facilities.

3. A building permit system based on soil type characteristics.

4. Ordinances preventing extension of water lines into unsewered rural areas.

5. Application of county land use controls to housing development density and types of disposal systems permitted.

6. Sufficient health department personnel to inspect all private systems and ensure rigorous enforcement of sewage system standards.

Alternate Systems

1. Make research funds available for development of more efficient and ecologically sound private systems.

2. Make money available to encourage construction of experimental systems and for replacement should these systems fail.

3. Tax breaks as an incentive to homeowners who improve or replace faulty systems or try new alternative systems.

Other

1. Encourage financial lending institutions to require inspection of disposal systems before granting loans to home buyers.

2. Construction of community or cluster sewage disposal facilities in areas of rural development.

In order to implement measures that will effectively manage the rural sewage disposal problem the counties that do not now have a health department should establish a county health department having an environmental health division and enough personnel to carry out sufficient survey and inspection activities. The counties should have responsibility for monitoring, permitting, and for ordinance enforcement in regard to private sewage disposal systems. The Regional Water Quality Council with cooperation from Comprehensive Health Planning in Southern Illinois should help counties in getting health departments funded and organized with adequate personnel.

Private sewage disposal maintenance systems should be encouraged so that adequate services will be available from the private sector for system maintenance. Classes in the set-up and operation of such a business

could be offered under Health Department sponsorship at a location in the 10-county area. Specific municipal wastewater treatment facilities with sufficient capacity to accept septage should be designated to serve as receiving stations for operators of private sewage disposal maintenance systems.

Educational programs are essential. Training in the evaluation of existing systems and in proper system maintenance should be offered by health departments to home-owners, prospective home-owners, contractors, realtors, home loan institutions, and maintenance system operators. More thorough training covering such things as seepage field capacility of soils, acceptable installation methods, assessing system needs, ordinances governing private systems, certification and licensing and alternate systems should be offered and required for building contractors, private sewage system contractors and developers. Health departments should also consider a certification and/or licensing program for building and private sewage systems contractors.

In areas adjacent to incorporated municipalities with wastewater treatment facilities, municipal governments should consider annexation and extension of sewer lines in order to alleviate existing rural sewage problems. In all cases of sewer line extension there should be written agreements concerning future annexation or other arrangement.

In rural areas land use controls or rural development ordinances should be initiated by the counties to regulate the location and density of housing development, in order to minimize or alleviate the potential for rural sewage pollution. The type of private disposal systems, method of installation and minimum lot sizes should be determined for rural development, based on soil capability and other natural characteristics of the region for on-site disposal of wastewater.

Implementation Goals and Funding

Except for the establishment of county-wide zoning and/or subdivision ordinances which make requirements designed to prevent seepage field failures the programs proposed here should be completed or under way

by 1983. Since the ordinances are subject to local government action and voter acceptance it would be difficult to set an implementation goal for them. However, the Regional Water Quality Council should offer to assist local governments in formulation of ordinances from the beginning of the implementation phase and should urge local governments to take actions that can be successfully completed by 1985. Educational programs should be under way in counties having a health department structure with environmental health personnel by 1981.

Funding of health departments divides about half and half as the responsibility of the county and the Illinois Department of Public Health. These proportions may alter where other funding sources may be tapped - an estimated $962,000 would be required to give health departments to Hamilton and Jefferson Counties and create an environmental Health Division for Perry County Health Department. This cost figure includes salaries, travel and equipment. Costs could be diminished if Hamilton and Jefferson Counties seek to form a combined health department and if Perry County draws on the Environmental Health Division of Jackson County for its needs.

Improved staffing other than that needed by the new department(s) and division are seen as requiring an overall personnel increase of five to ten positions. Additional salary and travel costs to the counties would range between $32,000 and $64,500 for these positions with the Illinois Department of Public Health share ranging between the same figures. Present understaffing and the extent of programs proposed here suggests that 208 program implementation would place requirements on the high side of this range.

Costs of the proposed additional educational programs are estimated at $28,000 for the 10 county area. Since most of this estimate is in the form of employee time devoted to education it is not a 100 percent add-on figure. More than half this cost would be picked up by state funds and current personnel costs.

No substantial costs to County Health Departments should accompany the fostering of zoning and subdivision ordinances. An average per-county cost of $15,600 per year has been estimated for the implementation and enforcement of these ordinances. However, it is recognized that the actual cost figure would vary considerable from county to county. It is assumed that initial ordinance development and related research will not be necessary since suggested ordinances are available.

Chapter 7

AGRICULTURE AS A NONPOINT SOURCE

Agriculture activities in the 208 area include row crop farming; hay lands; pasturing of animals; raising of chickens, hogs, and cattle in large number as meat animals; and dairying. These activities have impact on water quality through the accelerations of erosion, introduction of poisonous substances to the runoff, and addition of nutrient minerals and organic wastes to surface waters.

Various methods of control have been developed for these potential nonpoint sources of pollution. These include techniques to minimize erosion, methods of planning for wise uses of poisons and plant nutrients, and schemes for the handling of animal wastes. Control methods, however, are not fully applied.

The southeastern counties of Pope and Hardin have the least farming on a percentage of land use basis in the ten county 208 area. About twice as much land is devoted to forest land as to row crop farming in these counties. Jefferson and Hamilton counties in the northern part of the 208 area have the highest row crop land use percentage. Jackson and Williamson Counties have the greatest variety of agricultural and other land uses, plus large impoundments surrounded by forested areas and many orchards. There are few large feedlots or poultry operations in the 208 area.

Potential nonpoint sources of water pollution from agricultural activities in the ten county 208 area include soil transported by rain water runoff and wind; application of pesticides, herbicides, and fertilizer; and animal wastes. Of these, soil erosion by water contributes by far the greatest degrading influence on water quality. It has been estimated that there is an average annual loss from water erosion on rural land in the 208 area of 8,016,000 tons of soil. Over three fourths of this, or 6,089,000 tons, are estimated to erode from row cropped land; 1,074,000 tons from pasture land; 307,000 tons from wooded lands; and 546,000 tons from rural land with other uses[17].

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A comparison of soil loss from heavily forested counties with that from heavily row-cropped counties brings the sediment contribution of crop farming activities into finer focus. Pope County, with 38% forest acreage and about 20% row crop acreage, has an estimated soil loss per year of 2.8 tons per acre. Jefferson County, with less than 14% forest acreage and about 50% row crop acreage, has an estimated soil loss per year of 4.4 tons per acre.

It has been estimated from survey findings that 48,000 tons of chemical fertilizer and 260 tons of pesticides and herbicides are applied annually to farm and orchard lands in the 208 area[18]. Since erosion removes most surface material, a sizeable portion of these chemicals are transported to surface waters with eroded soil and in solution with precipitation runoff. There is no way to measure the amount of these substances that end up in surface waters each year, but the amounts present in water, sediments, and, in the case of pesticides and herbicides, in aquatic life forms can be measured.

Agricultural fertilizers entering surface waters add lime, nitrates, and phosphates to the sediments and water. Phosphate is often the limiting factor in aquatic systems which, by its short supply, keeps rapidly multiplying microorganisms in check so that they do not monopolize space, energy flow, and food supply. If the aquatic habitat is low in phosphorus, as is commonly the case in the 208 area, the entry of phosphates may lead to a eutrophication process which will seriously alter the aquatic community structure and change formerly clean water to organically polluted water with a dirty appearance and unpleasant odor. Die-off and decay of living things in the water will follow. The decay process will cause and increased demand for dissolved oxygen and many fish and fish-food organisms will die from oxygen lack.

Pesticides and herbicides entering bodies of water in the sediments soon begin to appear in the interface waters and in the tissues of immature insects, worms, and other animals that feed on organic materials in the sediments. Because of the large amounts of sediment ingested by these animals, very small concentrations of certain insecticides, primarily organochlorine varieties, in the sediments amplify to larger concentrations in their body tissues. Bass, bluegill, and crappie eat large numbers of these invertebrate animals. This further concentrates the poisons in their bodies. Large bluegill and bass eat the small fish and cause another level of concentration. The largest concentration will occur in birds and mammals that eat these fish. Man as a consumer of these fish may take in the highest concentrations of pesticides and herbicides in the environment.

Three major classes of chemical agents are active ingredients in pesticides. They are organochlorine compounds, organophosphate compounds, and carbomates. Of these, the organochlorines are most persistent in the aquatic environment. The most persistent may remain present for several years. If there are new inputs to a body of water during that time, these compounds will accumulate to higher concentrations with passing time. The use of some of these (DDT, aldrin, dieldrin, and chlordane) has now been prohibited. The organophosphates break down quickly by hydrolysis. Carbomates will persist in water about one month.

A state pesticide monitoring program has been proposed for Illinois, which would include the gathering of much needed information about the toxicity and movement of pesticides now in use in the aquatic ecosystem. Monitoring of pesticide concentrations in fish and fish-food organisms is included in the proposed program[19].

Heavy metals such as mercury are in sediments, and concentrate through the same food chain sequence. Mercury may enter stream sediments from agricultural use of compounds like methyl mercury dicyandiamide for treatment of seeds, but there are enough research results suggesting otherwise that an agricultural source for mercury pollution remains in doubt.

Animal wastes from covered holding areas, feed lots, and open pasture are possible sources of fecal bacterial contamination and organic nutrient enrichment. Manure cleared from holding areas and stored for eventual field application becomes a concentrated pollution source, if drainage is to a nearby stream or into subsoil aquifers. Feed lots provide highly enriched runoff which can pollute streams. Pasture land is not likely to be a great influence on water quality because population density is small and decomposition processes mostly occur in place.

Control Procedures

Control of potential threats to water quality from row crop farming is largely a matter of soil erosion control. Erosion control methods have been classified according to suitability for use in various regions of

Illinois. These practices were described as being directly beneficial in erosion and sediment control. The four practices considered most suitable for the regions found within the 208 area were conservation cropping, conservation tillage, crop residue use, and terracing and waterways.

Conservation cropping is full tillage with good management practices such as maintenance of soil alkalinity and nutrient levels, timing of tillage and seeding operations to avoid high erosion risk, and crop rotation including legumes and grasses.

Conservation tillage consists of growing crops in a limited zone of soil preparation with a larger area remaining covered. The soil cover may be a crop residue left on the surface or a natural growth cover. Methods considered suitable in the 208 area are zero-tillage, chisel planting, narrow strip tillage, and till-plant. The last method named is accomplished by scraping the soil of the raised crop row from the previous season's planting and planting in the same place. Crop residue use involves leaving a residue of the harvested crop during the non-growing season from harvest till planting time.

Terraces are constructed across a slope. They consist of an embankment and channel affording movement of surface water at a non-erosive velocity to a prepared waterway. A grassed waterway is most often used, but plastic lined or tiled drainways may be constructed. Soil conservation practices would also help control movement of pesticides, herbicides, and agricultural fertilizers into flowing and standing surface waters.

There is considerable work yet to be accomplished in regard to erosion control and soil evaluation in the 208 area. Both of these areas of concern have a strong relationship to water quality. Information supplied by Soil and Water Conservation Districts indicate that most lands in the 208 area are not managed to minimize erosion. Fifteen to fifty years will be required according to estimates to institute planning and management controls on crop and pasture land in the 208 area (see Table 15).

Table 15

CONSERVATION PROGRAMS (IN PART) OF SOIL AND WATER CONSERVATION DISTRICTS
ACCOMPLISHED, TO BE DONE, AND ESTIMATED YEARS NEEDED TO COMPLETE

(All figures in acres or years except # of plans)		Franklin	Gallatin	Hamilton	Jackson	Jefferson	Perry	Pope-Hardin	Saline	Williamson
Conservation Plans Developed & Reviewed	Done	823	438	459	597	706	344	754	724	402
	To Be Done	128	128	459	500	322	118	812	212	590
	Years to Finish	---	20-30	---	20	35	30	40-50	20	---
Detailed Soil Survey	Done	49,705	209,900	29,639	332,592	18,270	113,749	360,966	245,760	227,025
	To Be Done	201,444	none	29,639	none	345,090	169,750	none	none	none
	Years to Finish	---	---	5	---	---	---	---	---	---
Conservation Practices Applied										
Cropland	Done	17,586	80,718	NA	59,095	40,000	70,700	NA	80,718	10,673
	To Be Done	153,127	46,831	NA	75,000	180,000	103,000	NA	52,922	10,673
	Years to Finish	---	---	---	30-40	50	---	---	---	50
Pasture	Done	32,078	9,626	NA	33,570	29,000	10,659	NA	21,628	24,440
	To Be Done	5,091	8,483	NA	18,000	26,000	22,000	NA	9,381	24,440
	Years to Finish	---	---	---	15-20	25	---	---	---	50
Forest land	Done	40,119	18,614	NA	10,458	500	7,226	NA	15,157	5,710
	To Be Done	7,001	27,086	NA	78,000	4,000	32,000	NA	19,743	5,710
	Years to Finish	---	---	---	50-75	100	---	---	---	50
Total Land Adequately Treated	Done	48,599	148,754	82,788	142,576	67,319	123,626	167,038	46,221	92,439
	To Be Done	202,550	61,146	82,788	243,303	265,427	159,874	193,922	199,539	92,439
	Years to Finish	---	25	---	50-75	90	34	70	35	---

Table prepared from information collected by GERP&DC staff.

Commercial agricultural fertilizers contain various ratios of nitrates, phosphates, and potassium salts. Control measures to help prevent stream and impoundment pollution by these nutrient materials should take into account the degree to which they will be used by the current crop. In addition to soil erosion, control measures to prevent agricultural nutrification of surface waters should include:

1. Use of regular soil testing information and productivity information based on soil types and cropping history to decide the correct formula and concentration for each crop area.

2. Proper timing of applications, such as making nitrogen appli cations only at planting time.

3. Immediate incorporation of fertilizer into soil on sloping land.

4. Rotation of crops with appropriate decrease of nitrogen ratio after legumes.

Since pesticides and herbicides tend to persist for varying lengths of time before decomposing, it is necessary to choose between the various types with a knowledge of their longevity as well as their effectiveness. In addition to erosion control, control measures include choosing the shortest persisting compound for the job to be done and applying no more of it than is needed. Other suggested practices include:

1. Triple rinsing of concentrate containers.

2. Controlled separate conduct of concentrate and water to spray bar.

3. Crop rotation avoiding successive corn crops to reduce corn rootworm populations.

4. Use of integrated pest control/crop production systems integrating crop rotation, biological agents, tolerant crop varieties and pesticide use.

5. Increased research and education programs.

Pollution of surface waters by animal wastes is most difficult to control where large numbers of animlas are concentrated in a small space. Large feed lots are now required to obtain a permit as a point source and control all effluent from each feedlot. The following controls have been suggested involving manure disposal from all animal concentrations and runoff from covered and uncovered non-permit confinement areas.

1. Controlled runoff from dry storage and no storage over sand or cracked bed rock.

2. Use of slatted floors or open gutters with flushing to lagoon or to storage pit with overflow to lagoon. Pit manure can be land applied and lagoon can be dewatered via field irrigation.

3. Paved or unpaved open feedlots should be constructed with dikes or curbs to prevent flow through. Runoff should be directed to a holding runoff equal to the pen multiplied by 12-15 inches depth. Settling basin and holding pond also can be used with land application and irrigation capabilities.

4. Septic tanks with subsurface drainage fields are sometimes used for milking centers, but this would not be practical in much of the 208 area because of unsuited soil types.

Land application of manure or cleanings from settling basins needs to be controlled to prevent exceeding agronomic nitrogen or phosphorus rate (Nitrogen or phosphorus required for the expected crop yield for one season). On sloping land, application should be near planting time and with immediate incorporation into the soil. Manure should not be applied to frozen or saturated soil, near wells, or within 200 feet of surface water.

Water pollution from pastured lands is best prevented by not overgrazing, pasture rotation and fencing stock away from streams.

County Soil and Water Conservation Districts should be initially designated as management agencies. As such they would have responsibility to adopt annual work programs designed to implement water quality management activities directed at curbing soil erosion and at implementation of all specified agricultural Best Management Practices related to use of fertilizers, pesticides, and herbicides, and to disposal of livestock wastes. Implementation should concentrate first on priority areas according to the following sequence within each county:

1. Protection and improvement of public water supply waters and waters tributary to them.

2. Protection and improvement of waters with a primary recreational and secondary public water supply use.

3. Preservation and improvement of high quality waters.

4. Correction of severe erosion problems impacting year-round flowing streams.

The County Soil and Water Districts should develop an operations and funding plan and a program of on-going education to facilitate the implementation of management practices and inform the affected public of the rationale for prioritization.

Voluntary cooperation with water quality management needs should be continued subject to annual evaluation. Soil and Water Conservation Districts in cooperation with the Regional Water Quality Council should develop the annual evaluation system. Mandatory programs based upon available state and federal mechanisms should replace voluntary program if reviews indicate that voluntary programs are not effective.

The Agricultural Stabilization and Conservation Service should allocate at least 50% of its annual budget to cost-sharing programs within the designated priority areas. Resources of the Shawnee Resource Conservation and Development Project should also be concentrated on the designated priority areas.

Ninety percent cost sharing is recommended for application of Best Management Practices within priority areas to areas eroding at ten or more tons per acre per year (critical erosion areas).

Implementation Goals and Funding

Implementation goals are stated in terms of percent participation by land owners in prescribed erosion management practices. Goals for participation within critical erosion areas in priority watersheds are given as follows:

1979	-	1 to 5 percent
1980	-	5 to 10 percent
1981	-	10 to 20 percent
1982	-	20 to 33 percent
1983	-	33 to 50 percent

This means by 1983 a minimum of 33 percent of owners having critical erosion acreage in priority watersheds will be cooperators in soil conservation management programs. After 1983 larger percentages of cooperators and cooperators in lower priority water sheds will be actively sought.

Funding for the installation of erosion control practices will come from private expendatures and from USDA, SCS, and ASCS monies. During the first phase of funding (1978-1983) a total of $5.8 million will be needed with $.87 million coming from the private sector and $4.93 million from public funding. Funding between 1984 and 1995 would total $6.96 million from USDA/SCS/ASCS funds and $1.74 million from private expenditures.

A more detailed coverage of these considerations will be found in Appendix B-2 "Pollution Sources: Agriculture" attached to the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois.

Chapter 8

COAL MINING AS A NONPOINT SOURCE OF WATER POLLUTION

Coal is mined in the 208 area using both underground and surface mining techniques. Underground mining in the area is mainly via shaft mines (i.e., mines which gain access to coal layers through a vertical shaft through the overburden). The surface remains undisturbed in this kind of mining except for the processing plant location. At the processing location, surface acreage becomes covered with pyritic and other waste materials separated from the coal by washing and other processes.

Coal, from outcrop to more than 100 feet depth, is mined in the 208 area by surface mining techniques. Area type strip mining is used exclusively except for a few mines in the southeastern part of Southern Illinois where contour-type surface mining has been done. Figure 8 shows how area-type surface mining proceeds. Equipment used for over burden removal is the dragline in most cases. Some smaller mines use shovels and the wheel excavator is used at two sites in the 208 area. Scoops, shovels, and small draglines are used to pile or load coal in the pit once it has been loosened by blasting.

Great amounts of land acreage are disturbed in the surface mining procedures. This plus preparation plant refuse constitutes a dual potential for water quality degradation from surface mining for coal. The preparation of coal for consumer use varies somewhat according to its intended use in terms of the final size of coal pieces desired and special treatments applied. Most coal mined in the 208 area is destined for use in electric power generation. In general, processing of the raw coal includes 1.) storage to accomodate irregular flow of raw material from the mine; 2.) crushing using rotary breakers, roll type crushers, hammer mills, etc. in one or several steps; 3.) screening to sort out various sizes; 4.) washing with heavy media cleaning, hydrorotator, washing table, or froth flotation plants according to size and intended use; and 5.) dewatering and/or drying.

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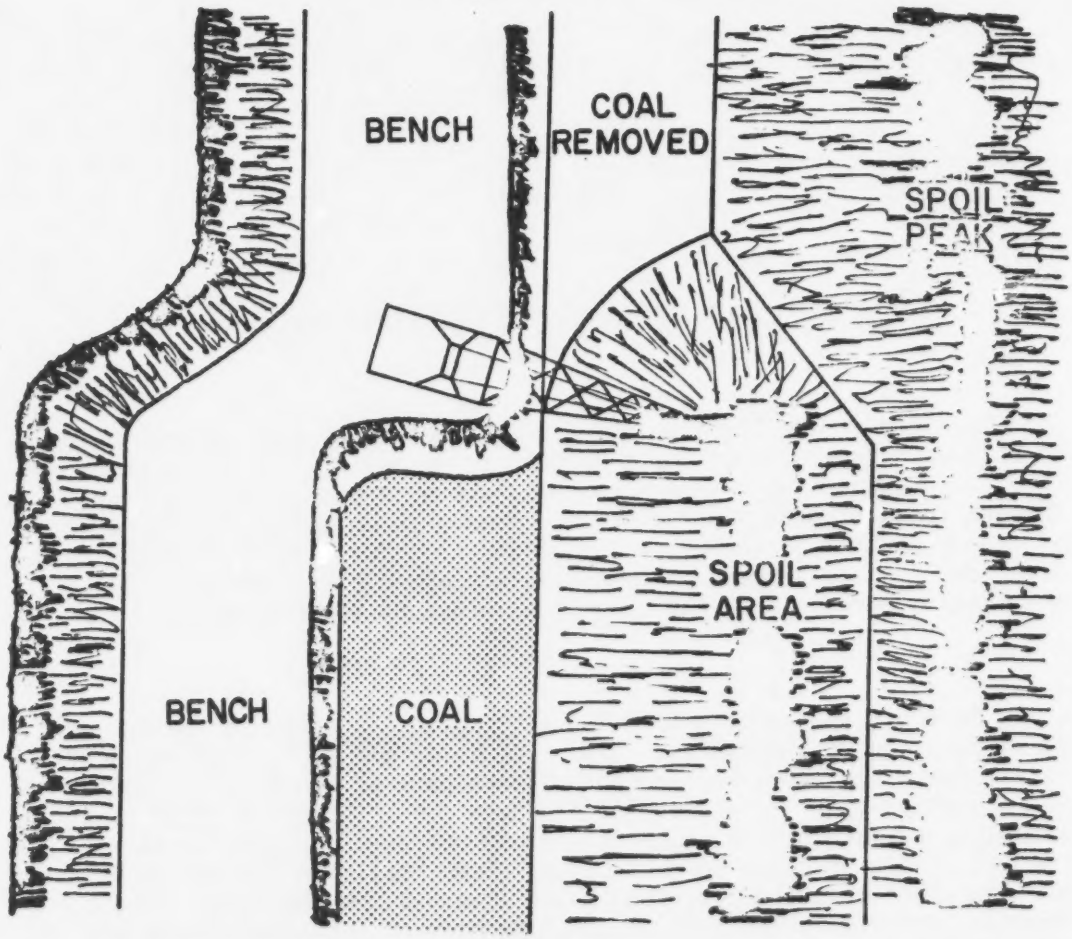
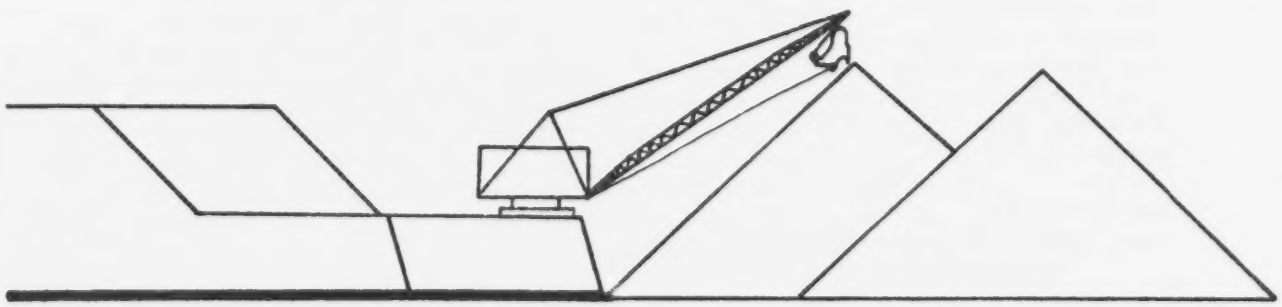
Figure 8

CONVENTIONAL METHOD OF SURFACE MINING



PLAN VIEW



END VIEW

Modified from Cassidy, S.M., Elements of Practical Coal Mining, American Institute of Mining, N.Y., 1973.

Transport of coal to and from processing plants may involve conveyers, haulage trucks, high tonnage dump trucks, railroads, or some combination of these. Where trucks, haulage, or railroads are used roadbeds must be prepared for this traffic.

A wide band of surface-mineable coal crosses the 208 area from northwest to southeast. Subsurface mined areas exist within and on either side of this band. Coal mining activities and/or reserves of mineable coal exist in each of the ten counties in the 208 area. Perry County currently has the most surface mining activity. The area of most underground mining activity is included in Jefferson and Franklin Counties where the "quality circle" still includes reserves of coking coal. There are few mines in Hardin and Pope Counties. Coal beds in these counties are small and discontinuous. No mines are currently operating in Hardin County.

Nature and Extent of Problems

Coal is made up of 70-90% organic and 10-30% inorganic compounds. The organic portion is hydrocarbons with oxygen, sulfur, and nitrogen forming various functional groups throughout the carbon skeleton. The inorganic constituents are mostly aluminosilicates and silica which form ash and fly ash on burning, and sulfides (mostly FeS) and carbonates of Fe, Mg, and Ca which are somewhat water soluble. In addition, there are trace elements which are potential contaminants. The most common of these are manganese, copper, lead, zinc, arsenic, and mercury.

Shales overlying coal beds may contain large amounts of pyrites (FeS) and other compounds also found in coal. Potential contaminants from coal and coal overburden that can enter the aquatic transport mode include soluble organic molecules, polyaromatic hydrocarbons, leachable minerals, and trace elements, and acid drainage. Of these, acid drainage poses the most obvious threat to water quality in the 208 area.

Acid mine drainage originates from both coal washings and from pyritic overburden. Unreclaimed surface mines and the sometimes huge gob piles of coal refuse at old processing sites are the source of most acid drainage problems in the 208 area. Rainwater filtering through these

exposed materials leaches out pyritic materials. In water at ambient temperatures with sufficient atmospheric oxygen available, reactions take place which result in formation of highly soluble iron sulfate and sulfuric acid ($2FeS_2 + 2H_2O + 7O_2 \quad 2FeSO_4 + 2H_2SO_4$ + heat). If there is sufficient oxygen and some buffering of the acid by basic compounds in the stream, iron sulfate will oxidize further and precipitate out as the yellowish insoluable ferric hydroxide and coat the stream bed.

If the stream is not well buffered and runs highly acidic, this final reaction becomes very slow and the deposition of ferric hydroxide is spread over long segments of the stream bed. This coating of the stream bed plus depleted oxygen supply and acid conditions limits the life supportability of the stream to a few adapted species or no life at all. In some 208 area locations even trees lining the streams have been killed by acid drainage. About 225 miles of stream in the 208 area have been affected by acid mine drainage to some measureable extent.

Of the water analysis parameters commonly used to monitor water quality, those most indicative of acid drainage are acidity, sulfates, total dissolved solids, and iron. PH values are also used as a check on acid conditions since they can be measured in the field. These parameters were measured over a six month period in 1976 for more than 60 monitoring stations in the 208 area. Both mine-drainage affected and unaffected stations were used.

At a stream which originates near Harco in Saline County and then flows through an old processing plant site between two large gob piles, measurements made approximately 1.5 miles downstream showed all five of these parameters in violation of state established water quality standards for every sample taken, except that iron was not in violation in one. Acidity ranged from 500 to 5,520 mg/l, iron from 0 to 1,900 mg/l, sulfate from 550 to 7,500 mg/l, total dissolved solids from 1,380 to 14,160 mg/l, and pH value from 2.0 to 2.7. The levels of chemical constituents beyond which a stream is in violation of state water quality standards for these parameters are as follows:

Acidity - 0
Sulfate - 500 mg/l
Dissolved Solids - 1000 mg/l
Iron (Fe) - 1.0 mg/l
pH Value - Between 6 and 9

Values for these parameters on the South Fork of the Saline River for samples taken upstream and downstream from an area of mine drainage input illustrates the effect of pollutants originating with the especially acid overburden and coal refuse found in mines in the southern part of the Saline Basin (Table 16). Note that pH standards were violated 20 times, sulfate 9, and dissolved solids 8 times in the 25 samples drawn from mine drainage affected stations while no violations occurred for these parameters upstream. This same pattern was evident for the other four months of monitoring.

A smaller area of particularly acid overburden exists near Carbondale. The effect of mine drainage from exposed overburden and slurry in this area is shown by results from monitoring sites above and below the unreclaimed surface mine area (Table 17).

In a biological study of these monitoring sites specimens of 31 species of aquatic macroinvertebrates (small animals living in and on the water and on in stream rocks and vegetation) were found upstream from the mined area, but only 2 species were found below this drainage. This was one of many examples of the loss of life supportability of streams due to acid mine drainage found during a biological study of six mine-waste affected streams in the 208 area. In the above example, fish were also present upstream, but ventured only a short distance below the entrance of the acid bearing tributaries.

These and other examples that could be taken from the same collected data show the tendency of mine drainage to push amounts of certain water quality parameters above accepted standards. There are no stated stream standards for suspended solids. It should, however, be noted that data collected in the studies mentioned above showed an increase in suspended solids at places below active surface mining.

Control of pollution from coal mining activites requires that acid spoil and refuse be either neutralized, removed from contact with surface or groundwater, or prevented from getting sufficient oxygen to carry out the oxidative reactions that produce the change in the state of iron from ferrious to ferric that occurs during the series of reactions which yield sulfuric acid and ferric hydroxide. Of secondary, but also great importance, is the need to limit sediment input to surface waters from erosion of land laid bare by surface mining techniques.

Table 16
VALUES FOR FOUR MINE-RELATED PARAMETERS AT STATIONS ON THE SOUTH FORK OF THE SALINE RIVER FOR JUNE AND JULY 1976
(Only the first station receives no mine waste drainage)

	pH					Fe (iron)					Sulfate					Dissolved Solids				
Month	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
June	6.6	5.5	6.3	6.5	4.7	1.8	4.8	2.7	2.4	3.5	250	350	150	250	1300	180	550	460	430	3700
	7.0	3.5	4.1	4.1	5.1	1.8	3.1	0.4	0.4	4.5	150	300	250	250	380	210	850	600	570	550
	6.6	5.1	5.4	5.7	3.8	1.7	1.2	1.0	0.8	6.9	35	500	350	350	600	115	530	530	540	840
July	7.1	5.4	6.0	6.0	4.2	1.6	1.8	1.6	1.6	3.6	45	275	225	225	600	125	390	360	365	610
	6.6	3.4	4.4	4.4	5.3	1.2	1.4	0.2	0.2	2.7	150	1000	875	875	200	225	1570	5350	1380	380
	6.8	3.0	3.4	3.6	3.6	1.8	3.1	1.8	1.1	12.5	125	300	675	725	750	215	1420	1220	1250	1350

Monitoring Stations Shown:

1 = ATHW-04
2 = ATH-05
3 = ATH-06
4 = ATH-07
5 = ATH-01

Source: From data collected by Greater Egypt Regional Planning And Development Commission and Staff.

Table 17
VALUES FOR MINE-RELATED PARAMETERS AT STATIONS
ON SYCAMORE CREEK IN JACKSON COUNTY
FEBRUARY AND MARCH 1977
(All figures are in Mg/l)

	Acidity		Fe		Sulfate		Dissolved Solids	
Month	Above	Below	Above	Below	Above	Below	Above	Below
February	0	310	1.32	41.8	146	485	385	800
	0	110	1.20	65.0	115	510	390	940
	0	70	2.0	17.0	138	450	360	770
	0	90	1.5	19.8	140	550	445	860
March	0	45	2.6	18.0	100	350	325	510
	0	18	2.7	11.5	120	265	350	500
	0	64	1.3	20.0	200	700	540	1220
	0	64	1.5	23.2	175	720	480	1240

Source: From data collected by Greater Egypt Regional Planning and Development Commission staff.

The Illinois Surface Mined Land Conservation and Reclamation Act constitutes a potentially good control in the case of present and future mining. Federal legislation enacted in 1977 will help assure that the reclamation requirements are met. The Illinois law with its amendments to date requires in general that the land be backfilled and graded to very nearly the original contours where the land was used for row cropland. The same is to be done with land whose soil and slope characteristics make it suitable for row crop use as shown by soil conservation service surveys regardless of former land use. This row cropable land is also to have its topsoil stockpiled separately and replaced to a depth of 18 inches with no rocks over 6 inches diameter included after grade restoration. Pasture and haylands not suitable for row crop must be graded so that no slope exceeds 15%; and forest and wildlife areas, if not suitable for row crop, graded so that no slope exceeds 30%. The final cut highwall must be reduced to 50% slope or less. Operators are also required to restore drainage to its original pattern where this is possible. Revegetation of all reclaimed land according to its intended use is required by this reclamation act.

To obtain a permit to proceed with mining operations or preparation of the mine site the operator is required to file information regarding ownership and location of the area to be mined and a detailed reclamation plan with the Illinois Department of Mines and Minerals and with the county board(s) in counties affected by the proposed mine. County boards may require a public hearing to ascertain public opinion about the reclamation plan for the proposed mine. Following a hearing, the IDMM has power to accept, reject, or require alterations in the operator's reclamation plan.

Other state reclamation acts contain additional requirements that would improve on the water quality protection provided by the Illinois law. Some examples are 1.) a time limit of one year for complete revegetation as required in Iowa, 2.) revegetation with primarily natural species as required in Montana, 3.) reduction of highwall to less than 50% slope (in Missouri 20% is required and in Maryland and Pensylvania the highwall must be "eliminated").

The results of past mining (i.e., old refuse piles, slurry ponds, and exposed ungraded overburden) remain a serious threat to water quality. Enforcement of the Illinois Surface Mined Land Conservation and Reclamation Act will not eliminate this source. Federal legislation in

the form of Public Law 95-87 Title IV - Abandoned Mine Reclamation - offers the potential for restoration of the worst problem streams through "emergency restoration, reclamation, abatement, control, or prevention of adverse effects of coal mining practices..." if "public health, safety, or general welfare" are endangered and if "no other person or agency will act expeditiously..." (Section 410).

Burying of acid refuse and overburden can accomplish both of the tasks that would prevent acid drainage formation - 1.) isolation from surface runoff and percolation water and 2.) isolation from sufficient oxygen to carry on oxidation reactions. Dumping of acid materials in pits with no water outlet except evaporization may serve the same purpose. Various schemes to neutralize the products of oxidation using lime or better natural buffering materials have been proposed but these may cause violation levels of dissolved solids in the streams.

To summarize, the need to control water pollution from acid mine drainage and increased soil erosion has brought about legislation which requires mine operators to carry out reclamation processes. These processes include:

1. Restoration of most land to near previous contours
2. Saving and replacing topsoil on row cropland
3. Revegetation of restored lands
4. Restoration of drainage pattern.

Elimination of acid drainage sources from mining not under the most recent state law will require:

1. Burial of refuse in old subsurface mines, or under deep layers of subsoil and topsoil
2. Disposal of refuse in non-draining surface mining pits.

New federal legislation will encourage research and projects directed toward elimination of acid drainage from old mines.

Control Implementation

County governments should continue to review surface mine permit applications with assistance from other agencies as traditionally done.

The Regional Water Quality Council should provide for regional consistancy to the process.

The following courses of action should be undertaken under the guidance of the Regional Water Quality Control Council if consistent with the state regulatory program under P.L. 95-87 when it has been set forth:

1. Removal of gob and slurry within specific stream reaches and water sheds, by backfilling and blind flushing into inactive sub-surface mines located within two miles of current population centers.

2. Control of gob and slurry so as to achieve the best reasonable obtainable water quality consistent with control cost curves within specific stream reaches and watersheds, using least cost methods.

3. Detailed technical and cost studies at each location will finally determine site-specific measures to be taken.

County Soil and Water Districts and other appropriate agencies will apply for funds for demonstration reclamation projects.

Municipalities and counties may recommend lands as unsuitable for coal mining to the Illinois Department of Mines and Minerals on the basis of (1) incompatability with existing land use; (2) possible significant damange to historical, cultural, scientific, and aesthetic value or to unrestorable natural systems in a proposed mining area; (3) prime agricultural lands providing significant supplies of food or constituting aquifer recharge areas; (4) natural hazard areas (having frequent flooding or geologic instability); or (5) watersheds of "non-degradation waters."

The Illinois Environmental Protection Agency or other appropriate state agency (Department of Mines and Minerals or Illinois Institute for Environmental Quality) should strategically monitor water quality so as to determine compliance or non-compliance with water quality standards (IPCB, Ch. 3&4), regulations pursuant to P.L. 95-87 and the terms and conditions of the respective mining permits.

Mine-related NPDES permits should be reviewed by the Regional Water Quality Council before issue. Other permits related to mine activities should also have this review.

These specific recommendations and others to be based on future data gathering or coal mining trends should be the recommendation or responsbility of the Regional Water Quality Council:

1. Effective acid mine control measures must preceed or be part of any further mining in the headwaters of Crab Orchard Lake.

2. Research should be conducted by the Illinois Institute for Environmental Quality to find more cost effective ways to deal with the severe, acid mine waste drainage problems in the lower South Fork of the Saline River.

3. Research and demonstration projects using sludge in spoil stabilization.

4. An analysis of potential water quality impact of large energy conversion facilities.

The Greater Egypt Regional Planning and Development Commission should maintain and update the mine wastewater and cost-optimization models for use in evaluating proposed mining and reclamation plans pursuant to P.L. 95-87.

Implementation Goals and Funding

Permit reviews and monitoring to determine compliance by coal operators with water quality requirements of state and federal laws are activities that will start soon and be continuous.

Research and demonstration projects and updating of the mine wastewater cost optimization model would be early activities of the implementation program.

Actual reclamation activity will commence first in water supply reservoir basins and in basins of reactional impoundments.

Three planning time steps are envisioned during which funds to be generated in the 208 area under PL 95-87 are projected. The total funds to be generated in each time period are given as:

1977-80	$32.4 million
1981-85	$40.5 million
1986-95	$127.2 million

Approximately 50 percent of this or assuming 9 percent inflation a sum with buying power equal to $49 million in 1977 is projected as the total funds available for reclamation projects in the 208 area. These monies will be administered by a state agency. The Illinois Department of Mines and Minerals, Illinois Abandoned Mined Lands Council and the Federal Office of Surface Mining will determine allocation of these funds according to a not-yet-decided formula.

The initial goal to achieve acceptable levels of pH and net alkalinity in the most affected basins will reach a total cost of $11,568,600. This expenditure would accomplish 50 percent removal of gob and slurry in the Pond Creek, Crab Orchard Creek and Middle Fork Saline River watersheds and 85 percent control of gob and slurry in the basin of the South Fork of the Saline Rivers. Availability of coal surtax monies should make this goal financially achievable before 1983. These matters are treated in greater detail in Appendix C3 Technical Report for the Southern Illinois 208 Mine Waste Control Program appended to the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois.

Chapter 9

SUMMARY AND CONCLUSIONS

Of the eight types of activities discussed in this report, four raise problems that pose a current serious threat to water quality in the 208 area. These are coal mining, agriculture, hydrographic modifications, and rural sewage.

The threat to water quality from coal mining results mainly from past activity. Acid mine drainage due to the filtration of rainwater through pyritic refuse and exposed pyritic overburden is affecting approximately 225 miles of streams in the area. In many segments of these streams, most or all mine related parameters for assessment of water quality are constantly beyond levels which violate standards of acceptable water quality. Many stream segments in the 208 area are toxic to all forms of life and aestheticly unsightly due to acid mine drainage. These waters are of no use to man, and are dangerous for wildlife and domestic animals. Erosion of soil from barren mined-out lands and from present mining activity is also a threat to water quality.

The threat to water quality from agriculture stems mainly from row crop practices. The water translocation of sediments to streams in the 208 area may reach an annual level of 8,016,000 tons of transported soil. Three quarters of this is removed from row crop acreage. There have been practices developed that could markedly decrease this level of erosion, but they are in use on only a small percentage of row crop acres. The sediment input to streams modifies the stream habitat, increases the rate of siltation annually decreasing storage capacity of many reservoirs by more than 1.5%, and carries with it such pollutants as pesticides, herbicides, nitrates, and phosphates. Animal wastes from feedlots or fields can also be an important pollution source.

The threat to water quality from hydrographic modifications in the 208 area is mostly a result of clearing and channelization of long segments of streams. The largest such project in the area has resulted in the straightening and deepening of 51.9 miles of channel in the Saline River

system. When the most current portion of the project is complete, all of the channelized portion of this system will be without trees and undergrowth as well. The lack of natural growth increases suspended solids load and siltation and raises water temperature in channelized streams. The elimination of meanders speeds water flow causing pollution problems to spread further downstream before natural processes can work to neutralize them. These practices also cause serious alteration of both the stream ecosystem and wildlife habitat.

The threat to water quality from rural sewage systems is a result of unplanned residential development, poor systems maintenance, and poor enforcement of public health requirements. Increasing numbers of dwellings are built in rural areas. Septic tanks and subsurface fields are constructed with most of these to deal with sewage disposal. But, the soils in most of the 208 area are not permeable enough for trouble-free operation of such systems. Home owners, unaware of the high attention to maintenance required by septic systems in 208 area soils allow the systems to fail or allow inadequate systems to be installed. Where rural population is concentrated, as it is for lake shore homesite plots, a large percentage of failing septic systems can contribute sewage seepage to the runoff which will enter and pollute surface waters. This problem is amplified when water supply is piped to such communities, but no sewerage has been installed.

The threat to water quality from fluorspar mining, petroleum extraction, silviculture, and construction is not great in the 208 area. Nevertheless, the potential for an adverse impact on water quality exists if these activities should be expanded. Fluorspar mining can increase fluoride, lead, zinc, and sediment in streams. Petroleum extraction can contribute locally large amounts of salt from brine pumped up with petroleum and held or piped to disposal wells. Silviculture and construction on large enough scale can be a source of appreciable amounts of dissolved and suspended solids entering surface waters.

Methods devised or needed to halt or diminsh the impact of these activities on water quality can be categorized as structural, procedural, or regulatory. An outline summary of such measures is given below for the major non-point pollution sources of the 208 area:

Acid Mine Drainage

Structural controls:

1. Closing flowage outlets from acidic water ponds
2. Pumping pyritic refuse into old underground mines and sealing of these mines.

Procedural Controls:

1. Stockpiling soil, rock, and refuse for original sequence re placement in surface pits
2. Burial of old refuse and acid overburden
3. Revegetation of surface mined lands

Regulatory Controls:

1. Enforcement of new reclamation laws with sufficient monitoring of results

Erosion from Row Crop Lands

Structural Controls:

1. Building of terraces and contour terracing
2. Construction of grassed waterways
3. Controlled runoff from stock concentration areas to settling basins and/or holding ponds

Procedural Controls:

1. Conservation cropping with calculated minimal applications of fertilizers and chemicals
2. Conservation tillage (limited soil disturbance)
3. Crop residue left to hold soil

Regulatory Controls:

1. Provision of valuable incentives for initiating and continuance of a total conservation plan for each farm with penalties for departure from the plan.

2. A mandatory program to be implemented if voluntary programs fail to produce sufficient levels of control practice application.

Clearing and Channelization of Streams

Structural Controls: (where channelization must be maintained)

1. Dams for upstream water storage to simulate natural water balance
2. Grade stabilization and sediment trapping structures
3. Structures to hold tributary drainage

Procedural Controls:

1. No modification unless shown that no alternative exists
2. Maintain original channel and clear by removal of snags and obstructions or use controlled auxiliary cutoff channel whenever feasible if modifications must be carried out
3. Cutoff oxbows should be reopened
4. Revegetate with grass, trees, and undergrowth to restore natural environment and wildlife habitat
5. Establishment of erosion control practices on acreage of watershed tributary to proposed modification site before modification proceeds.

Regulatory Controls:

1. Restrict land use and rule out channel modification in remaining tree-lined and/or meandering streams

Rural Sewage Problems

Structural Controls:

1. Construction of septic systems of sufficient capacity considering water inflow and soil type
2. Construction of alternate systems

Procedural Controls:

1. Training of contractors, suppliers, and owners in maintenance procedures and reasons for their recommendation

2. Proper maintenance of existing systems

Regulatory Controls:

1. Establishment of monitoring and enforcement methods for public health laws related to installation and maintenance of septic systems .

Implementation of these controls should be the responsiblity of the Regional Water Quality Council, its member agencies and various co-operating agencies. The specifics of control implementation are discussed in each of the previous chapters and in the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois to which this report is appended.

FOOTNOTES

[1]James C. Bradbury, Illinois State Geological Survey, Private Communication, February 1977.

[2]Illinois Department of Mines and Minerals, "Annual Coal, Oil and Gas Report", 1975.

[3]Illinois Department of Mines and Minerals, "Annual Coal, Oil and Gas Report", 1975.

[4]Illinois State Geological Survey, Illinois Petroleum Series #97, 98, 100, 103 and 107.

[5]William D. Burke, Hamilton County Soil Conservation Service, Private Communication, March 1977.

[6]Using 2.2 barrels of brine per barrel of oil (Illinois State Geological Survey, Illinois Petroleum #66), 1974 Oil Production in the 208 area would have yielded 6,664,141 barrels of brine.

[7]Problem Assessment, Non-Point Sources of Pollution as related to forestry activities in Illinois, forestry and fruit production subcommittee, Illinois Task Force on Agricultural Non-Point Sources of Pollution, 1977, Table 1.

[8]Michigan Department of Natural Resources, Water Quality and Forest Land Use In Michigan, 1977.

[9]Ibid.

[10]Ibid.

[11]Ibid.

[12]Wyche, Brad, "Stream Channelization: The New Flood Control Controversy", Unpublished Thesis, Princeton University, Department of Geophysical Sciences, April, 1972 (as quoted in "Report On Channel Modification," Volume I, Council on Environmental Quality, 1973.

[13]Emerson, John W., Channelization: A Case Study, "Science", Volume 173, July, 1971.

[14]Council on Environmental Quality, Clinton River Project, Report On Channel Modifications, Volume II, March, 1973.

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[15]United States Environmental Protection Agency, Non-Point Source Guidance Hydrologic Modifications, February, 1977.

[16]Miller, T.B., Staff biologist, Illinois Department of Conservation, Private Communication, 1977.

[17]Greater Egypt Regional Planning and Development Commission, Pollution Sources: Agriculture, Appendix B-2, 1978.

[18]Ibid.

[19]Greater Egypt Regional Planning and Development Commission, The Restoration And Maintenance Of High Quality Water, Appendix B-5, 1978.